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- Multi-WAN Load Balancing & Failover
- 2 x Gigabit Ethernet LAN ports with 120,000 NAT sessions
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- 500 x VPN & 100 x SSL-VPN tunnels with Central VPN Management
- High Availability Mode
- Object-oriented Firewall with Content Security Management (CSM) and QoS
- IPv6 x IPv4
- Multi-subnet WAN/LAN through 802.1Q
- Bandwidth management
- 2 x USB ports for 3G/4G LTE mobile broadband access, USB printer, storage, and thermometer
- Support VigorACS 2 management system
- Smart Monitor Traffic Analyzer (up to 500 nodes)

Vigor3220 Series

Quad-WAN Gigabit broadband router with Security Firewall, 100 x VPN tunnels, and 50 x SSL-VPN tunnels



- 4 x Gigabit Ethernet WAN ports
- 1 x USB port (USB3.0) support 3G/4G LTE mobile broadband access
- Multi-WAN Load Balancing & Failover
- 1 x USB port (USB2.0) support file sharing, external storage, network printer or thermometer
- 100 x VPN and 50 x SSL-VPN tunnels with Central VPN Management, Load Balance and Redundancy
- 1 x Gigabit LAN port with 100,000 NAT sessions
- 1 x Dedicated Gigabit Ethernet DMZ port for connecting servers
- 1 x Console port (RS232)
- Object-oriented Firewall with Content Security Management (CSM) and QoS
- IPv6 x IPv4
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- Support VigorACS 2 management system
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- High Availability Mode
- Object-oriented Firewall with Content Security Management (CSM)
- IPv6 x IPv4
- Comprehensive QoS features
- Multi subnet WAN/LAN through 802.1Q
- 1 x USB port (USB2.0) support file sharing, external storage, network printer or thermometer
- Central AP Management
- Central Switch Management
- Works with VigorACS 2 management system
- Smart Monitor Traffic Analyzer



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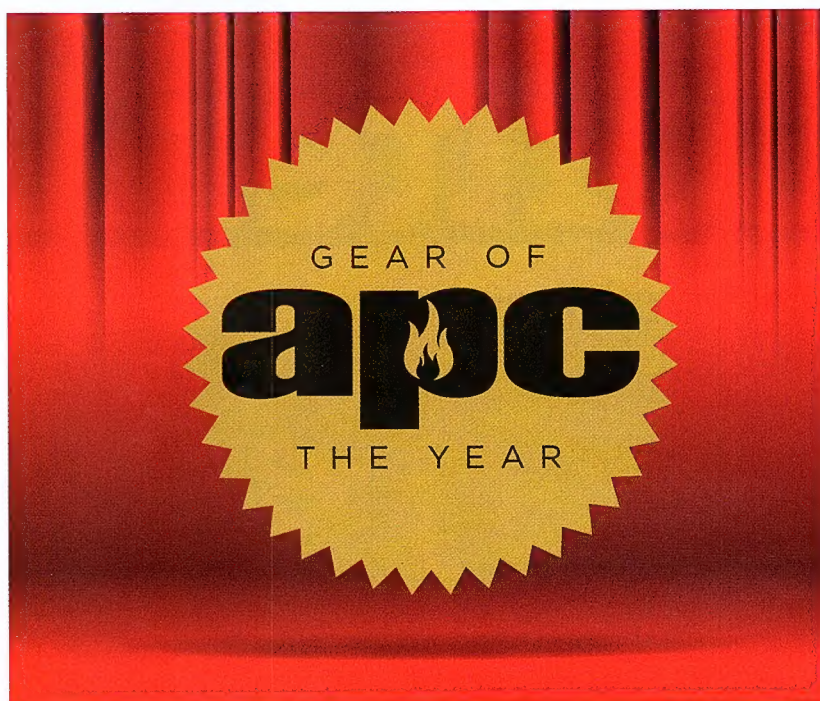
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Great things

Knowing what's best



Declaring winners is
problematic. One
could argue that
anointing a thing to
be the very best of its
class does great
injustice to many
other almost-there
products. And rightly
so. The many factors

that determine what's best include
value, and that changes as time
passes and prices drop, thus re-
ordering the podium. Or perhaps a
product we're looking at right now
gets a firmware update that enables
it to do new and more fantastic
things, thus elevating it a little
further up the ladder.

But that's time and change for you.
Always messing things up. What is
true is that in any given moment of
time, given sufficient expertise, it is
indeed possible to make lists and
rank things. And, that process is
entirely accurate in a given moment.
That moment, in our world of tech, is
now. Together, the boffins at APC put
minds to task, and have determined
with unassailable truthiness just
what deserves to be called 'the best'.

It begins on page 66, and over the
many pages that follow are our top
picks for just about everything that
matters in this corner of the world.
We do this every year, it keeps us on
our toes, inspires healthy debate in

the office and there were hardly any
arguments this time.

But the point is not to create an
excuse for the humans in the
building we work in to actually
engage with each other. No, it's so you
know what you should be hunting
down if you want the very best. This
is a natural extension of everything
we do for you at APC. We test things,
we use them in our lives, and we rate
them so you know if this gear is good
enough for you, and if it deserves
your dollars.

So having an ultimate list once a
year is the big annual yardstick. The
culling of the above average and the
elimination of all but the most
extreme excelsors. So, now you know
what's what and where it belongs in
the great hierarchy of consumer tech
gear. And, just in time for Xmas, too
- should you happen to want to
bestow something truly wonderful
upon a loved one, or just treat
yourself or the family.

As always, I love hearing your
thoughts, whether on this or
anything else that's interesting.
Until next month. ■

BEN MANSILL

EDITOR

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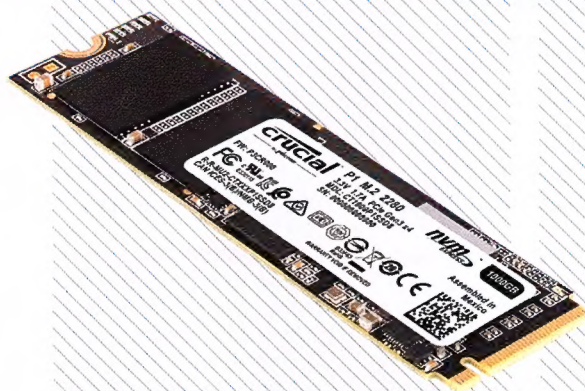
"Threadripper is all about providing unprecedented levels of desktop computing power."
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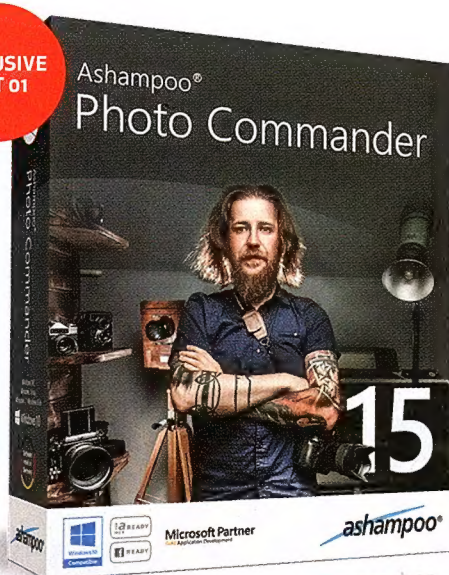
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ISSUE 462, CHRISTMAS 2018

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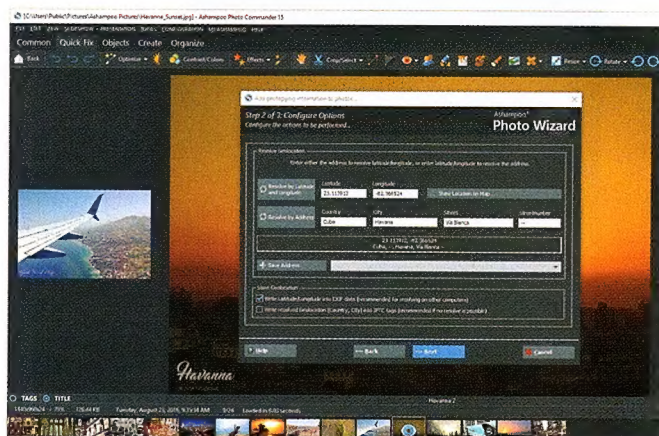
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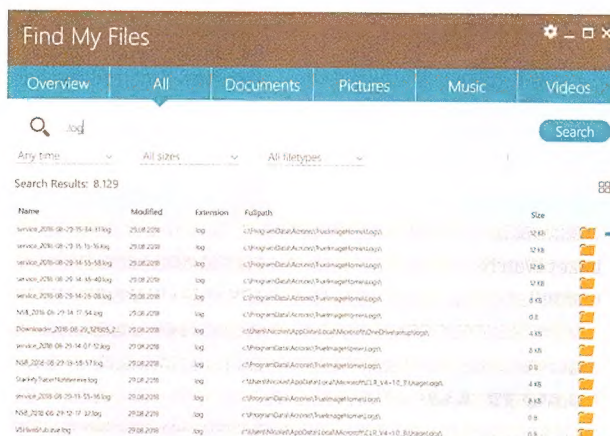
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Surface Laptop 2

Microsoft's professional clamshell resurfaces with Windows 10 and a new CPU.

The original Surface Laptop from Microsoft was a gallant first attempt in the professional ultrabook space, but it was too light on power to be useful for creatives and Windows 10 S was a bit restrictive for a professional laptop. It works much better on the new Surface Go 2 (a tablet), but forward a year however and Microsoft has transformed the Surface Laptop line from a promising category into a refined and on-point device that meets all of our initial expectations.

The heart of the new Surface Laptop 2 is a quad-core Intel processor which starts with a Core i5-8250U (there's no Core m3 model this year) and ranges to include a Core i7-8650U (the same CPU on Microsoft's gaming-capable Surface Book 2 tablet). This power jump isn't just clear on paper, we pegged a 78% boost in multi-threaded CPU power on Cinebench.

RIS from the last generation's i5 model. This means that instead of stumbling when running Windows 10 Pro (as the initial Surface Laptop did after upgrading from i5) you can actually now fire up a photo editing suite with a few Chrome tabs open and you'll still have plenty of processing power left in the tank.

Other than the updated CPU, not a lot has changed in the new Surface Laptop. Actually, that's an understatement: apart from a new Black colour scheme and the updated CPU, everything is identical to the original. It's got the same square Aluminium chassis and uses the same soft Aluminium finish on the bottom inside edge. It occupies the exact same 30.8 by 22.3cm footprint, folds to the same 1.4cm maximum thickness and weighs an identical 1.25kg. It even uses the same 13.5-inch 3.2 PixelSense display at the same 2256 x 1504 pixel

resolution. And yet, despite all this sameness, we couldn't be happier with it. The responsive 1.2mm travel and subbed top of the surface Laptop 2 keys makes it a joy to type on and the soft Aluminium keyboard surround and malleable beveled edge make it exceptionally comfortable to rest your palms on while typing. Marry this with a powdery and generously sized center trackpad and a perfectly weighted laptop hinge that makes the 3-point touch screen easy to adjust and yet sufficiently sturdy and you have a laptop that is blindingly easy to use.

The Surface Laptop 2 keeps a standard Surface-like port configuration, omitting the USB Type-C port entirely. This seems to be a sticking point for many, but it's not really as big a deal as it gets made out to be. The Surface Pro 2's single USB 3.0 Type-A port, Mini DisplayPort and 3.5mm headphone jack are a good balance of essential

interface options that'll offer the easiest solution for 90% of the things you'll need to connect. If you absolutely need USB-C for an external monitor then you can purchase a Surface Port to USB-C Adapter for \$110 and if you want a full dock arrangement then Microsoft's Surface Dock offers an impressive selection of connections for just \$300.

The Surface Laptop 2 comes in 4 colours (Black, Burgundy, Cobalt Blue and Platinum), can be configured with either 8GB or 16GB of RAM and offers 128GB, 256GB, 512GB or 1TB storage capacities. Whilst there are some additional limitations on configurations if you go for any colour other than Platinum, the 8GB RAM setup gives a choice of i5 or i7 CPU, with either a 128GB or 256GB storage capacity for a cost of \$1,499, \$1,999 or \$2,499. The 16GB RAM configuration only comes with a Core i7 CPU and either 512GB or 1TB of

Inside APC

Find out all about APC's editorial policies, test practices, how to read the benchmark results, and more.

APC is Australia's oldest consumer technology magazine - having been consistently in print for over 35 years, since our first issue way back in May 1980 - and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer - it's in our name, after all - the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, online services and beyond. We have two main goals: to track down the best of modern tech and also to help our readers make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And, like you, APC's journalists want to know what's good in tech - no matter what platform it resides on.

INDEPENDENT REVIEWS

Championing technology doesn't mean we're unrelenting yes-men and -women, however, and APC aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives - the best performance, best value and best features and, ideally, the products that offer the best mix of these three.

As a matter of policy, reviews published in APC are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an APC reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

LABS TESTING

Despite being a small magazine with limited resources, APC still strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance, gaming and battery life.

In most cases, for the benchmark results published in APC, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter are our preference due to their ease-of-readability, but tables are more compact, so we use these in cases where thoroughness is preferred.

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Apple refreshes MacBook Air and Mac Mini

FOR THE FIRST TIME IN YEARS.

Although both the MacBook Air and Mac Mini have lacked considerable refreshes for quite a number of years at this point, they both continue to have a dedicated fanbase. These fans have been appeased with the announcements of newer iterations (alongside another iPad Pro) at Apple's most recent hardware event, with both refreshes sticking to the form factor that brought them their initial attention, but with beefed-up internals. HD

IBM buys Red Hat in biggest software deal ever

SET TO BECOME WORLD'S LARGEST HYBRID CLOUD PROVIDER.

IBM has acquired open-source software company Red Hat, a move it describes as a "game-changer" in the world of hybrid cloud computing. Red Hat will continue to exist as a distinct business unit and will keep working together on its existing partnerships with Amazon, Microsoft, Google, and Alibaba. The deal has reportedly been approved by both company boards, and should be completed in the second half of 2019. HD

Four million Aussies were affected in Under Armour data breach

NEW INFORMATION REVEALED ABOUT MYFITNESSPAL HACK.

Fresh details have surfaced regarding the February 2018 data breach that affected 150 million users of the MyFitnessPal app, a service run by health and fitness company Under Armour. According to a newly-available document, "the company believes approximately 3,977,385 Australian user accounts were affected by the issue". Under Armour claims that it had sent all affected users email notices on March 29. HD



Huawei chairman hits back at Australian Government

Ban on 5G work is "beyond comprehension".

After comments were made by the Australian Government regarding its inability to protect critical infrastructure if Huawei was to work on the country's 5G network, the Chinese company has returned fire. Huawei chairman John Lord has labelled these claims as being "beyond comprehension", stating that Australia and the US are the only two major countries not using the company's internet equipment, as it is known to be the world's largest manufacturer of telecommunications network equipment.

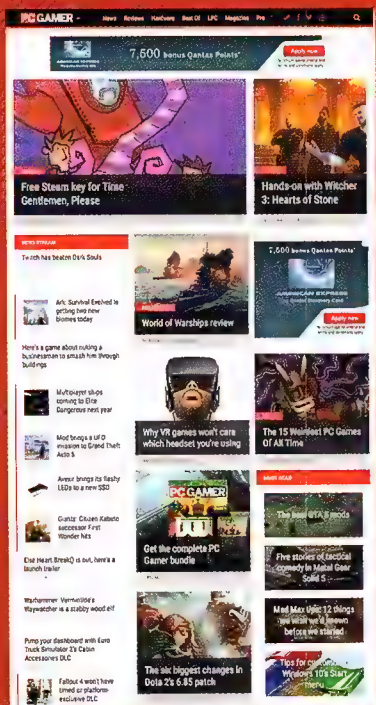
Huawei, and its sub-brand ZTE, were previously confined to manufacturing

'non-core' technologies such as antennae that had no involvement with the computational brain of the 5G network. The Australian Government's stance now is that it cannot ensure enough separation between core and non-core production – particularly when it expects our connected cities to be heavily reliant on 5G – so both manufacturers have been banned outright. "The distinction between core and edge collapses in 5G networks," said Mike Burgess, director-general of the Australian Signals Directorate. "That means that a potential threat anywhere in the network will be a threat to the whole network".

Harry Domanski

"Australia and the US are the only two major countries not using the company's internet equipment..."

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Facebook overhauls Oculus team to meet its long-term VR goals

NEW TECHNOLOGIES IS WHAT IS NEEDED.

Facebook bought Oculus for US\$2 billion in 2014 and, after three VR devices under its belt, the social media giant has reorganised the virtual reality team. The company admitted to *TechCrunch* that the shakeup was "internal" only and would not affect the consumer or developers. *TechCrunch* believes that the overhaul could lead to smoother flow of ideas between the devices and technologies teams, allowing the two to merge to deal with challenges as a single team. SS

Chinese firms indicted by the US for corporate espionage

TRUMP ADMINISTRATION CRACKING DOWN ON CHINESE SPYING.

Two companies based in China and Taiwan, along with three individuals, have been indicted by the US Justice Department for conspiring to steal trade secrets from American semiconductor company Micron Technology. While the Trump administration tries to crack down on alleged Chinese espionage, China is asking for evidence. "If the United States truly has genuine concerns, it should provide real examples to test these remarks that can stand up under evidence and facts," a spokesperson for China's Foreign Ministry declared. SS

Social media can be used to accurately predict crime, say researchers

LOCATION, LOCATION, LOCATION!

Researchers at the Royal Melbourne Institute of Technology (RMIT) have developed algorithms that, they claim, can be used to trawl through social media data to predict where and when a crime will occur. Using location data from Foursquare users in Brisbane and New York, the team hopes this will help police better allocate patrols. Trials in Brisbane were 16% more accurate than current crime prediction models. SS



Founder of the world wide web launches campaign to save the modern internet

Tim Berners-Lee wants a "Magna Carta for the web".

Tim Berners-Lee has watched his creation become an abusive platform with the spread of fake news, hate speech and political manipulation. Now he's launched a global campaign to save the internet. At the opening of the Web Summit in Lisbon, Portugal, recently, Berners-Lee has asked governments, tech companies and the public to sign a "contract for the web" to ensure people's rights and freedoms are protected online. The contract, published on the World Wide Web Foundation website, has already been signed by more than 50 organisations and calls for immediate action.

Dubbed the "Magna Carta for the web", the document requires governments to ensure its citizens have access to the internet at all times "freely, safely and without fear". It also asks tech companies to make the internet affordable to everyone, while respecting consumer privacy and personal data. The contract also calls for companies developing new technologies to ensure the internet is "a public good that puts people first".

Berners-Lee admits that it will be hard to quantify the success of this campaign, but is confident it will lead to conversations between governments and firms, and "put the power back in the hands of the people". Sharmishta Sarkar

Aussie are increasingly opting for higher NBN speeds, claims ACCC

IT'S THE NEED FOR SPEED.

The Australian consumer watchdog has released its latest findings on the state of the NBN and has revealed that just under half of total NBN users have shifted to plans with speeds of at least 50Mbps. Out of a total of 4.5 million NBN customers, 2.2 million are currently on high-speed broadband, with NBN50 taking out the lion's share.

The ACCC has also revealed that bandwidth per household has also increased, indicating telcos are now purchasing more NBN capacity (CVC) than before. However, the data on the increased bandwidth comes ahead of a discount scheme NBN Co is about to end, which could result in changes in congestion levels on the network.

The watchdog has also offered an insight into the best NBN plans currently available to customers, and which telco has the best speed performance. TPG came out on top in every respect. According to data collected from 790 speed tests across the country, TPG has the best download (88.4% of maximum speeds) and upload speed (89.1%).

Sharmishta Sarkar

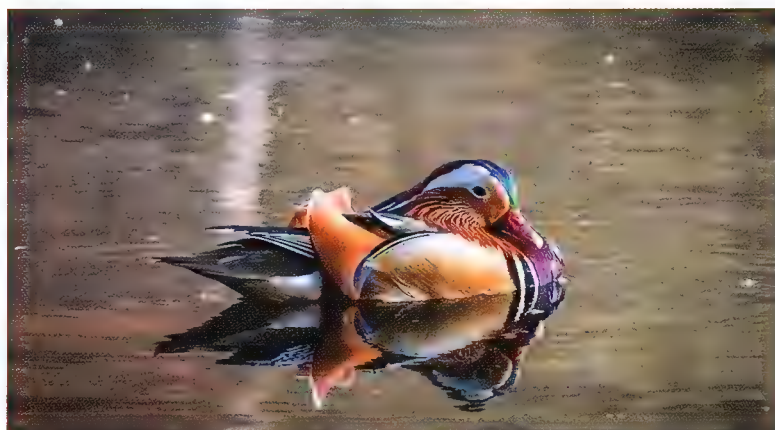


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techradar.com

numbercrunch

» WE LOOK AT THE NUMBERS DRIVING THE BIG TECH NEWS



30 MILLION

DUCKDUCKGO'S DAILY SEARCH VOLUME HAS INCREASED BY 50% SINCE LAST YEAR

Although it took privacy-centric search engine DuckDuckGo 7 years before it hit an average of 10 million daily searches, its next two milestones didn't take quite as long. In the next year, traffic doubled to 20 million daily searches and, as of today, has hit 30 million, marking a 50% increase over this time last year. The intention of DDG is to offer a search engine that doesn't track user activity or serve targeted ads.

000000

KANYE WEST EXPOSES HIS ALARMINGLY SIMPLE iPhone PASSWORD IN THE WHITE HOUSE

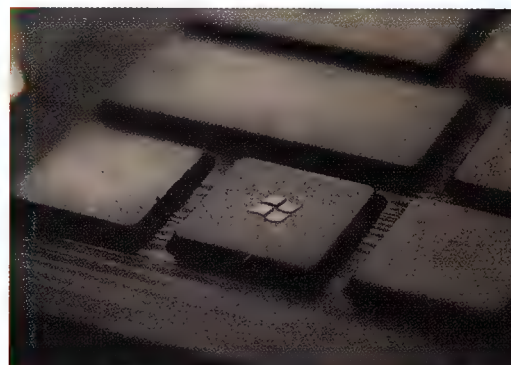
While visiting the White House to chat to President Trump, Kanye West accidentally revealed to live TV cameras that his iPhone password is just a series of zeros. We recommend you avoid using one of the world's most commonly-used lock-screen codes. Anyway, here's a quote from the rapper during his chat: "This is our president, he has to be the freshest, the flyest, the flyest planes, the best factories, and we have to make our core be in power."



NZ\$5,000

POTENTIAL FINE IF YOU REFUSE TO HAND OVER DEVICE PASSWORDS WHEN ENTERING NEW ZEALAND

New Zealand has now enacted its Customs and Excise Act 2018, which means that anyone refusing to hand over their phone or laptop password when entering the country can be fined NZ\$5,000. Just to pour salt in the wound, customs officers will still confiscate your devices to be forensically searched if you refuse to disclose your password, effectively leaving those targeted with no way to challenge the 'request'.



60,000

MICROSOFT HAS OPEN SOURCED THOUSANDS OF ITS PATENTS TO PREVENT LINUX FROM GETTING SUED

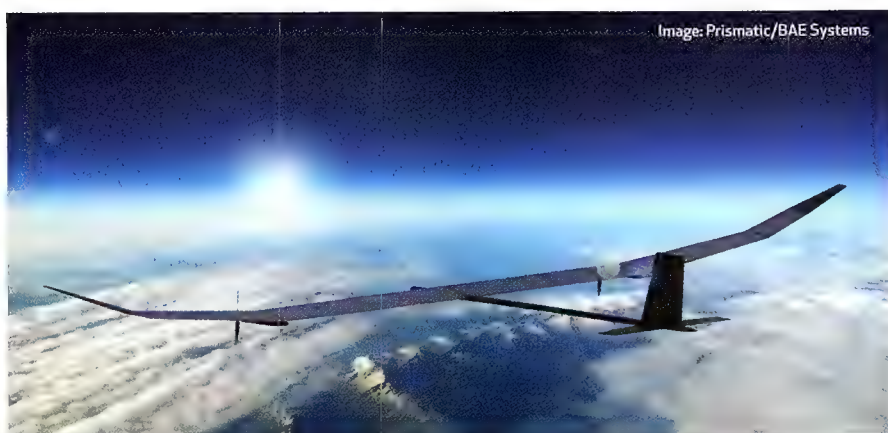
In what seems to be the latest push in Microsoft's developer-friendly reinvention, the company has made tens of thousands of its registered patents open source. The tech giant has joined the Open Invention Network, which is a patent group dedicated to keeping Linux safe from lawsuits, and in the process Microsoft had to make some concessions... 60,000 of them.

Connecting the world to the internet

Connecting billions of people around the world to the internet is still a First World problem.

The rate at which technology is advancing is rapid – it's changing the way we communicate with friends and family, the way we work, and the way our children are educated.

And it's all on the back of the internet. Yet, there are nearly four billion people in the Developing World who still have no access to the internet. Being unable to take advantage of the a connected world is not restricted to African and Asian nations, however – there are millions of people in rural America and in remote communities in Australia that are still offline. Large, extremely well-funded tech companies like Facebook, Elon Musk's SpaceX, and Google are, however, trying to bridge the digital divide, finding new and innovative ways to connect the remote corners of the world.



The solar-powered drones that can stay airborne for a year

New generation of UAVs could be used for communications.

British aerospace company Prismatic is working on a solar-powered drone that can stay airborne for an entire year without any need for maintenance. The Persistent High Altitude Solar Aircraft can carry a payload of 15kg, and has the potential to replace satellites for communications in off-grid areas, for remote sensing, Earth observations, and surveillance of all kinds. It's the most advanced of a new class of autonomous unmanned aerial vehicles (UAVs) – better known as drones – and it should be ready for tests in 2019.

Can Elon Musk make internet via satellite faster?

Space internet.

He might be the man behind SpaceX and Tesla, but Elon Musk's plans may go well beyond space travel and fast cars. Tech writer Gavin Sheridan has speculated that Musk, via SpaceX, plans on delivering high-speed internet connectivity directly from satellites, to millions of devices. SpaceX has approval to launch 11,943 satellites to low orbits for improved latency. Sheridan's thinking is that Musk will enable SpaceX to more cost-effectively launch thousands of relatively small, low-orbit devices for a complete global network, which would, in turn, transmit to ground stations.

Facebook's internet satellite went up in smoke

But that's not stopping Zuckerberg from trying again.

Facebook launched its Internet.org initiative in 2013 to connect the poorer countries of the world to the internet. As part of the project, the company developed the Amos-6 internet satellite, capable of producing speeds faster than its larger geostationary counterparts. That satellite, however, went up in smoke in 2016 when the SpaceX rocket it was hitching a ride on exploded during testing. Facebook CEO Mark Zuckerberg has sunk more money into the project, though, and has confirmed that the social network giant wants to launch Athena, its next internet satellite, in early 2019.

Telstra commits to connecting Australia's wide open spaces to 5G
It's a challenging country to connect.

While 5G is fast, the signal isn't far-reaching. For a country like Australia, with populations in remote communities, that would mean spotty mobile coverage. Telstra boss Andy Penn, however, is "confident" that the final 5G standard will allow the reach of individual mobile towers to be extended from 35km to 200km. While this would mean better coverage in the bush, there are no guarantees that Telstra's 5G network will be as good as its current 4G footprint. The telco is currently testing 5G in some regional areas, but has integrated the new tech with its 4G setup.

Project Loon: could balloon-powered internet connect the Australian bush?

It's really not such a looney idea.

"A network of balloons travelling on the edge of space" is Google's way of bringing the internet to areas that are offline. The project has partnered with service providers around the world to supplement the existing infrastructure. Not only does this offer connectivity to remote areas, it also sets up networks after a natural disaster. Signals are beamed to the balloons in the stratosphere from existing towers, then passed along the balloon network which is sent where it's needed. Project Loon has been tested in Australia and New Zealand in the past, although "no balloon-powered internet for Aussies [exists] just yet". ■

gadgets

» GOOD GEAR

NANOLEAF CANVAS

Not just another brick in the wall.

\$320 | SHOP.NANOLEAF.ME

Nanoleaf's prism lighting panels have long been the go-to setup for anyone looking to make a feature of their smart lights, but the company has a new panel that it's hoping to square-off for anyone wanting a more uniform arrangement. The new Canvas LED panels have a squarer, 8-bit aesthetic and come with touch sensors so that you can interact directly with each panel. You'll be able to sync the Canvas panels with any games you have running on your PC or with ambient music in the home, and there's a raft of new schemes and animations to light up your home life.



FITBIT CHARGE 3

Fitbit's finest fitness tracker gets further finessed.

\$229.95 | WWW.FITBIT.COM

Fitbit's Charge series have held the title as the best fitness trackers for a couple of years now, largely because they cleverly balance full featured health tracking and affordability. The new Charge 3 is the first to offer SATM waterproofing and swim tracking, plus a new SpO2 sensor and compatibility with the on-wrist FitBit Pay system. These new premium features join the return of connected-GPS activity tracking, a 7 day battery life and impressive heart rate tracking (including VO2 max estimates). What's still potentially the biggest perk however, is the streamlined app that offers a wealth of data to keep on top of your sleep, weight, food intake and fitness level.

SEGWAY NINEBOT GOKART KIT

A neat segway to a cooler company.

US\$1,299 | WWW.SEGWAY.COM

With the release of the Drift shoes, the Kickscooter and MiniLite in the last year, it appears that Segway is going through a bit of an identity crisis... and we couldn't be happier about it. What's perhaps the most exciting product to emerge from this carousel of innovation is the Ninebot Gokart Kit. Riding (literally) on the coattails of a Segway MiniPRO, the Ninebot Gokart Kit attaches to the front of the hoverboard and uses it as rear wheel propulsion. Pulling 0.7 Gs this powerful electric quad can accelerate from 0 to 20km/h in just two seconds and the cart comes with a mechanical handbrake for drifting... or just stopping.





HOVERSURF

Like a ride on lawn-mower...
for the skies.

\$150,000 | WWW.HOVERSURF.COM

We've been waiting for hover-bikes since we first clapped eyes on the speeder bikes in *Return of the Jedi*, but we weren't expecting them to arrive as early as 2018. To our surprise, California-based engineering company Hoversurf has created the first quadcopter drone to carry a passenger, and it's actually light enough to fall into the 'Ultralight Aircraft' category of the US Federal Aviation Authority's guidelines – so you don't need a pilot's licence to fly one. Considering how blender-like those propellers look, though, we'd probably recommend you get one anyway...

OCULUS QUEST

On a mission for true wireless VR.

\$399 | WWW.OCULUS.COM

At the end of September, Oculus announced that it would be releasing a new standalone VR gaming headset that'd be significantly more powerful than its smartphone-level standalone Oculus Go VR system. Expected to arrive sometime in the second quarter of 2019, the Oculus Quest will offer onboard six-degrees-of-freedom tracking, Touch controllers and compatibility with over 50 fully-fledged VR titles like *Robo Recall*, *The Climb* and *Moss* at launch. With a dual display resolution of 1,600 x 1,400 pixels and 64GB of storage space, this totally untethered experience could greatly expand the parameters of VR.



DELL ULTRASHARP U4919DW

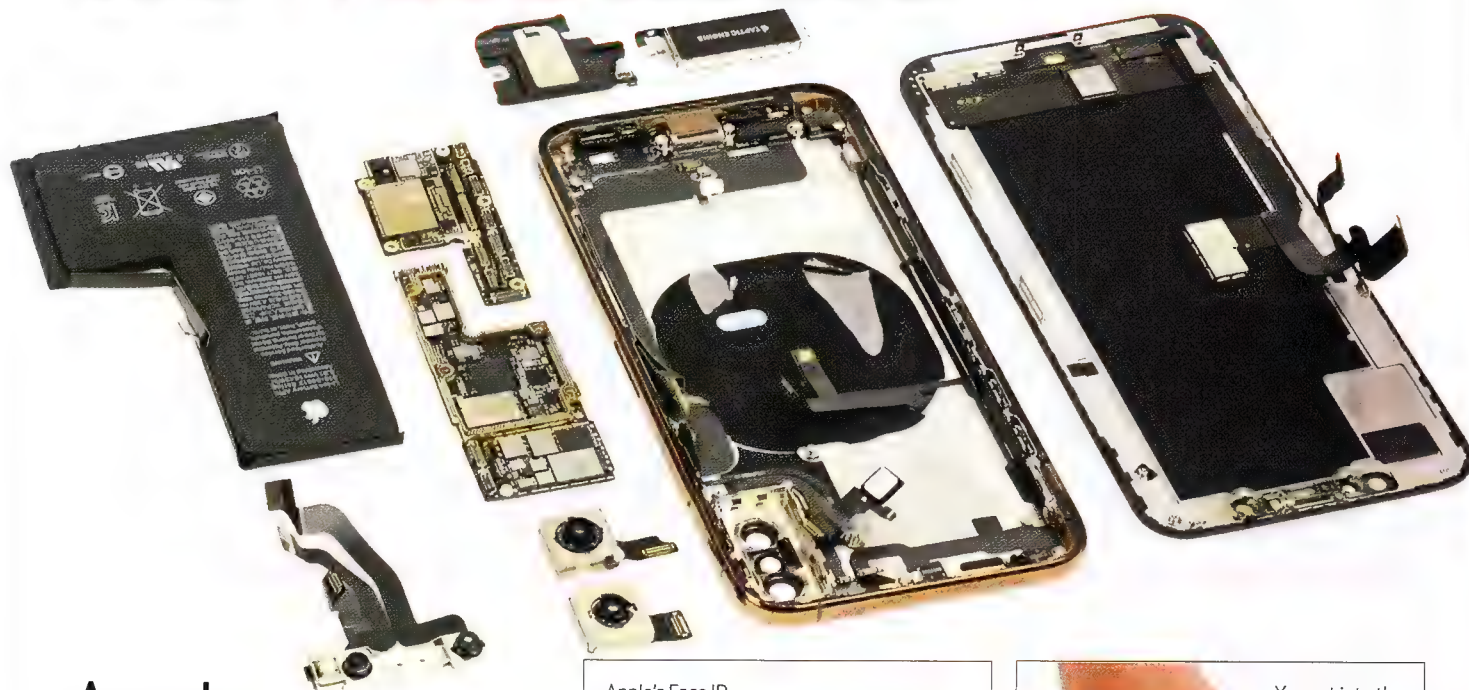
Putting you at the centre of your computer screen.

\$2,799 | WWW.DELL.COM



Ultrawide has proven itself to be an excellent monitor form-factor over the past couple of years. When paired with a 1800R curve, the wider 21:9 and 31:9 aspect ratios offer a better layout for multitasking in the one window, and can also create a seamless immersive gaming experience. Dell's 49-inch curved U4919DW isn't a gaming monitor, so unlike Samsung's similar CHG90 it doesn't offer GPU syncing, a 144Hz refresh rate or lower latency. And it's also \$700 more expensive. So what makes it appealing? Well, the Dell U4919DW does bump the pixel count up to 5,120 x 1,440, which could be a welcome bonus for pixel-intensive work tasks. Think of the spreadsheets... ■

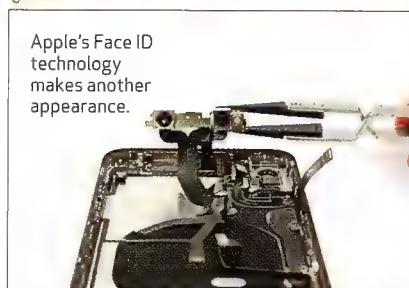
how it's done



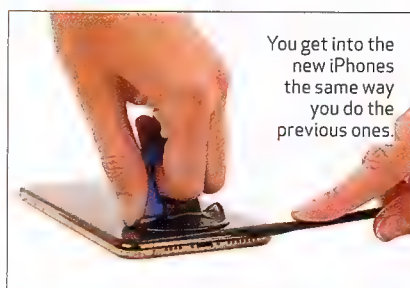
Apple iPhone XS

Scheduled disassembly.

Apple's Face ID technology makes another appearance.



You get into the new iPhones the same way you do the previous ones.



BACKGROUND

- Last year's iPhone X had a weird name and the most advanced internals we'd ever seen. Now Apple turns it up to 11 with the iPhone XS and XS Max. We're taking apart the XS, so grab hold of your Roman numerals, and let's get started.

MAJOR TECH SPECS

- Hexa-core A12 Bionic SoC with a "next-gen" Neural Engine
- 5.8-inch (2,436 x 1,125-pixel) 458 ppi Super Retina OLED display with True Tone, wide color gamut, and 3D Touch
- 12MP rear cameras (wide-angle and telephoto) with f/1.8 and f/2.4 apertures and OIS, and 7MP selfie cam paired with TrueDepth Face ID hardware
- 64GB of onboard storage (256 and 512GB optional configs)
- Gigabit-class LTE (not 5G), as well as 802.11a/b/g/n/ac Wi-Fi, with MIMO, Bluetooth 5.0, and NFC
- Improved dust and water resistance with an IP68 rating

KEY FINDINGS

- Apple may be changing up its naming scheme, but we're glad it left the opening procedure alone. Our

iOpener softens the hidden adhesive, then a suction handle and halberd spudger free the display. Though we feared Apple might use more adhesive to achieve that IP68 rating, we fared no worse than with ye olde IP67-rated predecessors.

- With the topside peripherals dispatched, we can turn our attention to the most important part of every S-series iPhone: the logic board. Having seen this kind of board before, we've got good at pulling this PCB sandwich apart.
- The S-year often comes with a camera upgrade, and Apple had a lot to say about these new sensors. The wide-angle sensor size has been increased by 32%, and pixel size has also been increased. One thing Apple forgot to mention about the new camera: All that 32% had to go somewhere, and the camera bump had to grow a little — your iPhone X case may not fit your iPhone XS.
- The XS packs a 10.13Wh battery (2,659mAh at 3.81V), weighing 39.5g — slightly downgraded from last year's X. But this decrease in capacity comes with a wild new battery configuration. Rather than using two cells to fill this L-shaped recess, Apple has constructed an

all-new single-cell battery.

- What was revolutionary last year is quickly becoming standard — the XS comes with a sensor array for Apple's fancy Face ID tech. The Taptic engine and loudspeaker come out in an assembly, but easily separate.
- It looks like the rear glass is still sandwiched between the camera bump and the frame with dozens of tiny welds. Despite the many improvements, it's got the same iPhone 8/iPhone X back glass construction, meaning one tiny crack calls for a whole chassis replacement.

Repairability score: 6 out of 10 (10 is easiest to repair). Critical display and battery repairs remain a priority in the iPhone. A display can be replaced without removing the Face ID hardware. Liberal use of screws is preferable to glue — but you need Apple-specific drivers (Pentalobe and tri-point) in addition to Phillips. Waterproofing complicates some repairs, but makes water damage less likely. Glass on front and back doubles the likelihood of drop damage and if the back glass breaks, you'll be removing every component, and replacing the entire chassis. ■

epinions



"Other forms of PC get coverage in the mag already, it would be good if some page space is put aside for the humble desktop PC"

WHERE KODI GOES

I refer to APC magazine December 2018 Issue 460, and the Kodi Setup Guide on page 50.

In section 14 The Perfect Startup on page 52 the advice from the magazine is to copy the Kodi.exe file into the Startup folder. Doing that is setting the system up for a possible future bug. The problem is that you now have two copies of Kodi.exe. If Kodi gets an update you can bet that the Kodi.exe in the Startup folder is still at the old level. It would be better practice to instead create a shortcut to Kodi.exe and put that in the Startup folder.

Bob Denton

INTERNET PHONES

I have just joined Aussie Broadband. The Aussie "Australia Tech Help Dept." tell me that my VOIP phone connection will only work when I am switched on to them. When I close my computer's internet connection then I have no telephone connection. The phone will only work when my computer is switched on and connected to 'Aussie'

This sounds pretty crazy and a needless addition to my electricity account. Do all ISP companies have this system?

Carol

Ben Mansill replies: *Hi Carol, and thanks for writing in. Some good news – you do not need to have your computer on to use VOIP. As long as your modem is on and connected to the internet that's all you need. The VOIP handset will be connected to the modem, likely via a provided adaptor. So, when you turn your computer off just make sure you leave the modem on. The downside to VOIP is that, obviously, you do need to be online, so if there's an interruption to your internet service then the phone won't work. So, always have your mobile handy if you need to make urgent or emergency calls when this happens.*

MORE PC IN APC

I have subscribed to PC&TA for some time after joining from PC World years ago. I have read many of your

publications over the years from the local library.

I would like the continuation of the Market Watch segment from PC&TA and even any expansion. I have always been a desktop fan and would like this section to be wholly dedicated to this segment. Other forms of PC get coverage in the mag already, it would be good if some page space is put aside for the humble desktop PC. Also please look at pricing the PCs to the average user and have sections around \$1,000, \$1,000-1,500 and \$1,500-2,500. I feel showing systems of \$3,000-6,000 would be a small percentage of the market.

Jason

Ben Mansill replies: *Happy to oblige, Jason! If you look to page 76 there's our new Blueprint section, and it does just what you're looking for. The price bands aren't exactly the same as your request, but we certainly cover the low and medium range comprehensively with our builds and coverage. And yes, there's also an extreme high-end build, but we couldn't help ourselves. ■*

APCMAG@FUTURENET.COM

Come on, have your say!

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Crunch culture endures despite known detrimental effects

The workers putting in 80 hours a week are usually the ones who don't get credit, writes Shaun Prescott.

Elon Musk announced in November that he was putting in 120 hour work weeks to get the Tesla Model 3 out the door in time. He did so with the usual braggadocio, but added, in an interview with Recode, that it was the "worst year of [his] entire career" and that he felt like he'd aged five years. More recently, Rockstar Games CEO Dan Houser boasted to Vulture that the studio was working "100 hour" weeks in the lead-up to *Red Dead Redemption 2*'s much-anticipated launch.

It won't come as a surprise to anyone that, completing tasks the likes of which Musk and Houser do, require more hours than a regular weekday 9-to-5 could accommodate. As luminaries in their respective industries, both have a huge investment in their work – they live it. They are their work.

But what about the workers? In the same interview with Recode, Musk mentioned that "everyone" at Tesla were working 100 hour weeks, and that there was no other way to achieve their target. While Houser claims that only a

tight-knit inner circle of writers were working 120 hour weeks at Rockstar, later reports suggest that the average worker for the studio was putting in 80 hours: a bit less than double what most would expect to work.

There's no doubt that most folk who work at Tesla and Rockstar, if not all, are passionate about their work and want to see it succeed. But it won't be their names strung up in fairy lights when history seeks to commemorate *Red Dead Redemption 2* or the Tesla Model 3. No, it'll be the head honchos, the ones whose sacrifice is very personal. The coder or engineer who put in 80-100 hours a week, ignoring family and rest because it was mandated by the company, will not figure in the thoughts of a games or car enthusiast when they put their money down.

And it's not just a question of who gets credit in cases where there's a big celebrity face representing the work of thousands: "crunch culture" is endemic in the games industry. For those interested in working in games, "crunch" is part and parcel with the work. But in

the end, these are workers being exploited by the corporations that employ them. Whether it's an accepted part of the industry or not, the long term effects of crunch cannot be compensated for with bonuses or overtime rewards. A 2016 Kotaku report gathered multitudes of anecdotes from within the games industry and it painted a dire picture: weight loss, depression, broken families, sleep deprivation, and ongoing psychological disorders.

Coming as they did within the same month, revelations of Tesla and Rockstar's crunch culture has revitalised a permanently tricky question: what are the ethics of consuming products created under these conditions? Of course, the same question can be applied to virtually everything we buy: clothing made in sweatshops, smartphones made at Foxconn... Virtually every transaction in the 21st century carries a hidden ethical compromise, but we might start by ceasing to celebrate overwork as "noble" and "good". Or perhaps, as unlikely as it seems, legislate against it. ■

END USER

Share your stories!

If you have an interesting story about technology users, their experiences and the issues that affect us all (whether funny or serious), email us at apcmag@futurenet.com. All correspondence becomes the property of APC and is subject to editing. Letters must include writer's full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.

software

» APPS FOR ALL THE PLATFORMS



Windows SOFTWARE

Adobe Premiere Pro CC

Will Premiere Pro's latest improvements benefit your workflow?

\$28.50 PER MONTH | WWW.ADOBE.COM

A lot has happened to Premiere Pro over the last year, with Adobe releasing three major updates to this longstanding Mac and PC video editing software in late 2017/2018.

If we were to cherry pick new features the first would be the new Learn platform, which offers three interactive tutorials to quickly teach you how to best use the software.

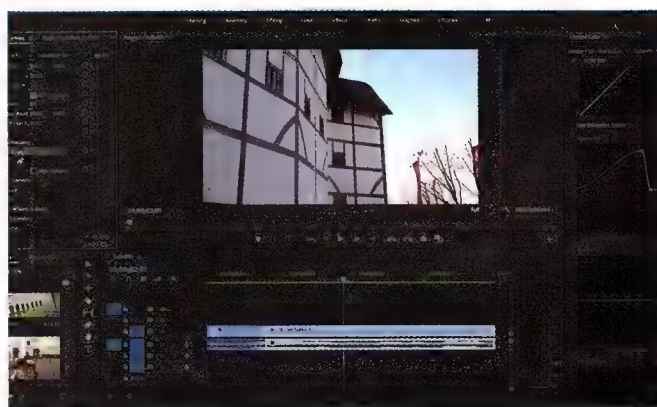
The ability to open multiple projects seems like it should've been implemented a long time ago, but this omission has now been rectified. You can also see multiple projects organised in tabs and move media and edits freely between them by dragging and dropping.

The colour of Premiere Pro and the special effects extravaganza, After Effects, are also now consistent. If you go to Preferences > General, you'll see a new checkbox called "enable colour display management". With this on, you'll have a dedicated colour pipeline between these two programs.

After Effects templates can now be used directly from within Premiere Pro. This is a neat space saving feature considering it once required you to have the entire After Effects suite installed concurrently.

The Essential Graphics section has also added the ability to move multiple layers at once by pinning a layer to another. When you highlight multiple text layers you can now alter the properties of all of them at the same time – for say, tracking or colour, for example.

If you've ever struggled to match the color between



shots, you'll love the fact that Premiere Pro can now analyze the color of one clip and apply it to another by simply clicking 'Apply Match'. There's even a face detection option to make sure the skin tones are as consistent as possible.

Premiere Pro CC has also tweaked the Lumetri effects to now let you apply multiple layers to any one clip, and set them up to affect only specific parts of your image.

There's plenty of new features that join Premiere Pro CC's long list of capabilities, a good indication that Adobe is working hard to improve the app and will continue to do so.

■ Steve Paris

HitFilm Pro review

A VIDEO EDITOR WITH POWERFUL COMPOSITING TOOLS ON A BUDGET.

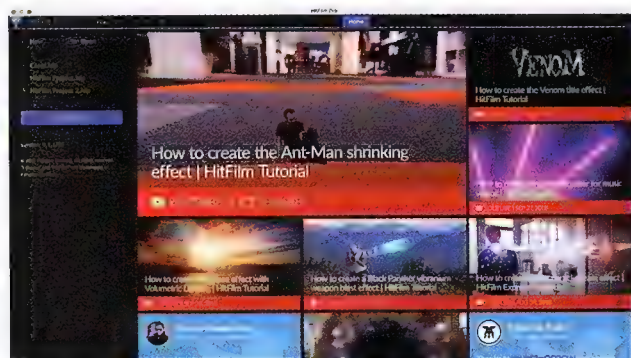
US\$299 | FXHOME.COM/HITFILM-PRO

FXhome's HitFilm Pro is one of many video editing apps for Mac or PC fighting for your attention, but this unique software manages to offer an unbeatable effect library for the price.

HitFilm Pro is an advanced video editing tool and compositor, which means you can cut a movie and apply effects to it (like colour correction or green screen), all within the same software package.

The workspace on display is versatile enough so you can easily change the layout to suit your needs, adding, removing or reordering panels as you see fit.

When it comes to editing it's easy to import your media, preview it, set in and out points, and insert clips into your project. Where HitFilm Pro truly shines however, is in the visual special effects department. This is this app's biggest selling



point, as it offers hundreds of effects and presets. It's nice to see a developer sticking to the traditional approach in developing a tool that you can actually purchase outright, with included free updates for a year. ■ Steve Paris



Mac » APPS



"Parallels Desktop tackles the VM storage dilemma with automatic disk monitoring."

Parallels Desktop 14

Upgraded virtualisation, now with better performance.

\$109.95 (\$71.45 UPGRADE) | FROM PARALLELS.COM | NEEDS OS X 10.11.6 OR LATER

The ability to run Windows, Linux, and other operating systems from a Mac with virtualisation software is pretty cool. And it's an essential productivity boost if you juggle multiple platforms for college or work. But virtual machines (VMs) are known to eat up precious resources like storage; a basic Windows installation requires at least 15GB of space, with our own Windows 10 virtual machine weighing in at upwards of 50GB.

Parallels Desktop 14 for Mac tackles this storage dilemma in several ways, saving as much as 20GB by providing automatic disk monitoring with ongoing advice to keep things running smoothly.

Don't expect massive decreases from a single virtual machine, though – instead, savings add up by chipping away at the size of each installed virtual machine. With a total of nine VMs on our review iMac, we didn't come close to saving 20GB, but reclaimed at least a few gigabytes.

While previous versions were

capable of manually reclaiming disk space, the option was buried in the settings for each individual virtual machine. This process is now streamlined by Free Up Disk Space in the File menu, which displays all available virtual machines in one place and allows you to quickly manage snapshots (now 15% smaller), resume and shut down, reclaim disk space, or archive those that are used infrequently for greater storage reduction.

SLIMMER AND FASTER

The application itself is also slimmer by about 150MB (mostly thanks to the comprehensive support documentation moving online), and noticeably faster at starting up – Parallels claims as much as 80%, and we can confirm this is a very real improvement you'll benefit from every time you use it.

Booting Windows and launching apps installed in those virtual machines is also faster by up to 35%,



You could potentially save up to 20GB by using the new Free Up Disk Space option in the File menu.

and there's a slick option to automatically optimise video memory usage. A resource monitor panel can be summoned from the Window menu to keep tabs on virtual machine processor and memory usage in real time.

Finally, now that macOS Mojave is available, Parallels offers full support for Apple's latest, including Dark Mode and running the system inside a virtual machine. ■ JR Bookwalter



Linux » OPEN-SOURCE SOFTWARE

Gnome

A popular desktop for Linux systems with more than 800 active developers behind it.

FREE | WWW.GNOME.ORG

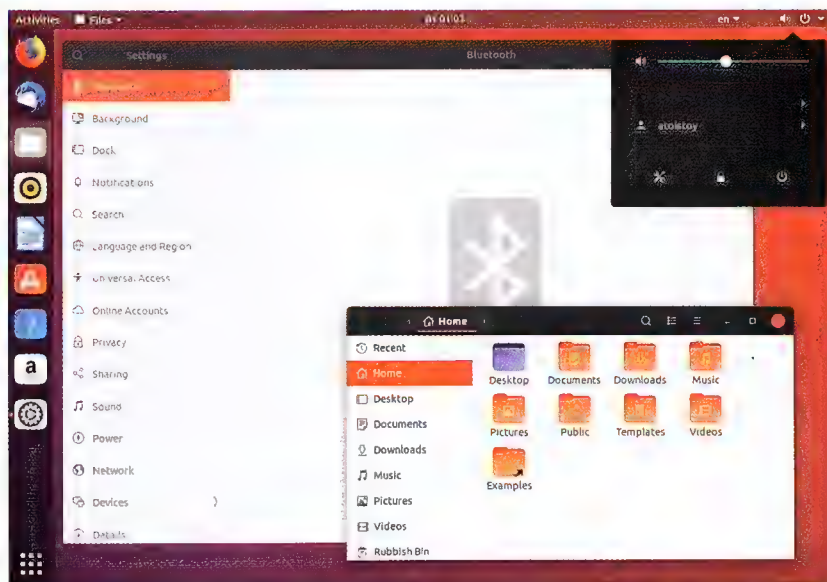
Despite the fact that the Linux audience is split into supporters and opponents of the Gnome Shell's design, there's no doubt that this is the most actively developed desktop for Linux.

Gnome is backed by Red Hat and Canonical, and enjoys wide adoption by Fedora and Ubuntu users, along with many other distros. The new Gnome 3.30 is an evolutionary release with a collection of small changes that enhance the overall user experience. Taking the latest version of Gnome for a spin is straightforward, because the official project web page suggests downloading demo ISOs that are based on Fedora Rawhide and openSUSE Tumbleweed.

There are quite a few things that we enjoyed in Gnome 3.30, particularly the performance improvements in the main desktop shell. The Gnome JavaScript component (GJS) now uses the latest SpiderMonkey 6 engine and consumes fewer resources. In general, the new Gnome doesn't seem to leak memory in a long session anymore. It feels snappier and more fluid, even when multiple applications are running at once and dozens of windows are spread among its workspaces.

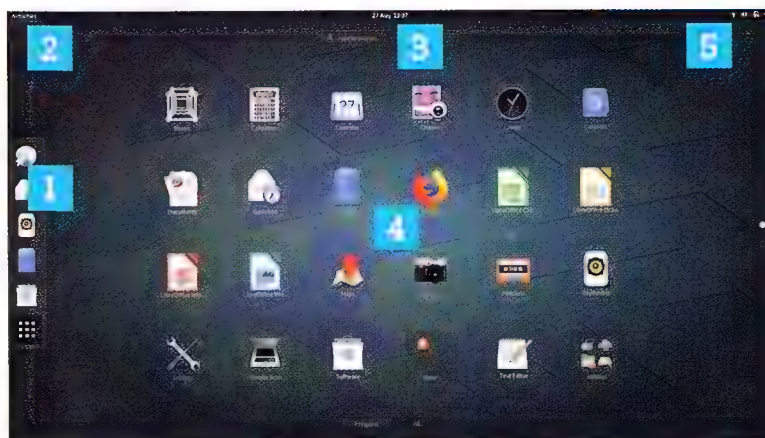
The improvements continue. Boxes now support RDP and allow for seamless remote access to Windows machines, the stock web browser (Epiphany) now has a read mode, the Software Center is now capable of updating Flatpaks (though this is a very Fedora-centric feature) and there are lots of refinements in Games that will interest those into retro gaming. Developers will appreciate the new auto-completion engine and interactive tooltips in Builder, the Gnome's IDE.

We were impressed by the amount of positive changes in this release. The Gnome desktop gets a lot of care and attention and feels polished. As usual, though, it's still recommended that you spice it up with extensions, apply more sensible window management and maybe some extra indicators. For instance, the Dash to Dock panel has seen its 64th release right before Gnome 3.30. It's available along with other extensions at <https://extensions.gnome.org>.



"Gnome 3.30 is an evolutionary release with a collection of small changes that enhance the overall user experience."

Exploring the basics of Gnome 3.30



1 APPLICATION AND TASK BAR

The default side bar in Gnome only appears in the Overview mode. The dotted button brings up a grid of installed programs.

2 CONTROL YOUR ACTIVITIES

The button in the top-left corner reveals all currently open windows.

3 SEARCH FIELD

Find installed programs, documents and visited web pages. The field is also integrated with the software store and suggests applications that you might want to install.

4 THE APPS GRID

This looks like a mobile interface zoomed for a desktop. The switcher below shows all available programs or just frequently used ones.

5 INDICATORS AREA

There's no System tray in Gnome, but this top-right zone is similar to one. The right-most element hides volume and power options.

Head to head: Intel Optane cache drives

Chris Szewczyk investigates whether Intel's cache drives actually deliver real-world benefits.

Intel's Optane storage technology has all the potential to be a game changer. According to Intel, Optane products have the capability to be orders of magnitude faster than traditional SSD solutions, never mind traditional hard drives. While there are already large capacity Optane drives that serve as NAND SSD replacements on the market, their cost relegates them to those with deep pockets or for use with professional applications.

Intel's plans for the mainstream market are much more grounded in reality. The excellent low latency read performance characteristics of Optane products makes them ideal cache drives. Pairing a low capacity Optane drive with a mechanical hard drive promises to massively

accelerate performance, while keeping costs to a minimum. These are lofty promises, and in this article we'll go over why a cache drive can benefit your desktop system or laptop, and put Optane's caching capabilities to the test.

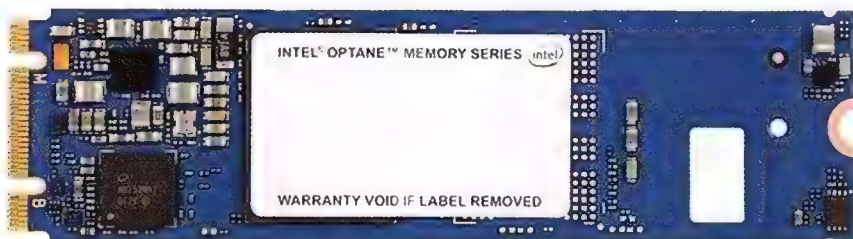
The Optane Memory Module uses a standard M.2 2280 form factor. It's compatible with 7th Gen Kaby Lake and newer processors. It requires BIOS support and is used in conjunction with Intel's Rapid Storage Technology. Optane drives are increasingly being offered as options in laptops, with the affordability of 16GB and 32GB drives and compatibility with standard M.2 slots making them a simple add on. When enabled, the Optane drive is invisible to the user; it acts purely as a background cache.

To test the effectiveness of Optane technology as a cache solution, we configured two identical-spec Dell Inspiron 5570 laptops, one was equipped with a small and affordable 16GB Optane drive, while the other was not.

THE CASE FOR ADDING AN OPTANE CACHE DRIVE

What is it that makes an SSD perceptibly faster than a mechanical hard drive? It's primarily the access times and random read operations. Your operating system is accessing small files all the time, and when you pile up thousands of these small reads, the difference between the millisecond access times of a HDD and the microseconds of an SSD become painfully obvious. The purpose of a cache drive is to bridge the gap between inexpensive HDDs and more expensive large capacity SSDs. Essentially you get the best of both worlds – affordable high capacity HDD storage combined with SSD level performance.

The 16GB Optane drive we're using here goes for under \$40. Many newer laptops, including the Dell Inspiron models we used for testing, offer it as standard or as an option. Admittedly



Optane SSDs used as cache come in M.2 form factors.

CrystalDiskMark 6.0.1 x64		
File Settings Theme Help Language		
All	5	1GiB
C: 3% (30/919GiB)		
	Read [MB/s]	Write [MB/s]
Seq Q32T1	99.61	88.23
4KiB Q8T8	1.172	1.566
4KiB Q32T1	1.173	1.530
4KiB Q1T1	0.435	1.470

The HDD offers very poor performance.

CrystalDiskMark 6.0.1 x64		
File Settings Theme Help Language		
All	5	1GiB
C: 2% (23/919GiB)		
	Read [MB/s]	Write [MB/s]
Seq Q32T1	922.5	154.0
4KiB Q8T8	570.5	161.5
4KiB Q32T1	280.2	161.2
4KiB Q1T1	122.3	73.32

But with an Optane cache, well, the results speak for themselves.

"When you pile up thousands of these small reads, the difference between the millisecond access times of a HDD and the microseconds of an SSD become painfully obvious."

16GB is not very big, and you'll likely see better results with a 32GB or higher drive, but if you do that, you're getting towards the price of a standalone SSD. If you're on a budget and want an affordable way to give your system a boost, we think its money well spent.

HOW DOES IT PERFORM?

Let's look at the two CrystalDiskMark results above. The one on the left shows the storage transfer speeds using just the hard drive, while the one on the right shows the same spec system with Optane caching enabled.

These results are not just in another league — they're in another sport. It's embarrassing really, but the numbers don't lie. How does it 'feel' though? Well, the laptop boot time is massively improved. During bootup without Optane enabled, you can hear the hard drive going crazy accessing all those tiny files. Even after reaching the Windows desktop, there is some lag before being able to open an application such as a web browser. With Optane caching enabled, these delays are largely absent.

Due to the small size of the drive, actual test results are highly variable as data gets moved on and off the cache drive quite regularly. Everyday frequently accessed applications, like a browser or spreadsheet, get quite a speedup, but something requiring a large amount of space like a game sees little benefit. We tried opening and closing *Far Cry 5* a few times and we

did see improvements, but doing so also flushes a lot of the cache, particularly core OS files, which is where the real benefits are to be found. This makes the 16GB drive we tested here best suited to an everyday internet/work/study/media-consumption machine. Gamers using a hard drive as their primary storage should look towards a larger Optane cache drive, or take the slightly more expensive option: and grab an SSD capable of holding entire games.

IS IT WORTH IT?

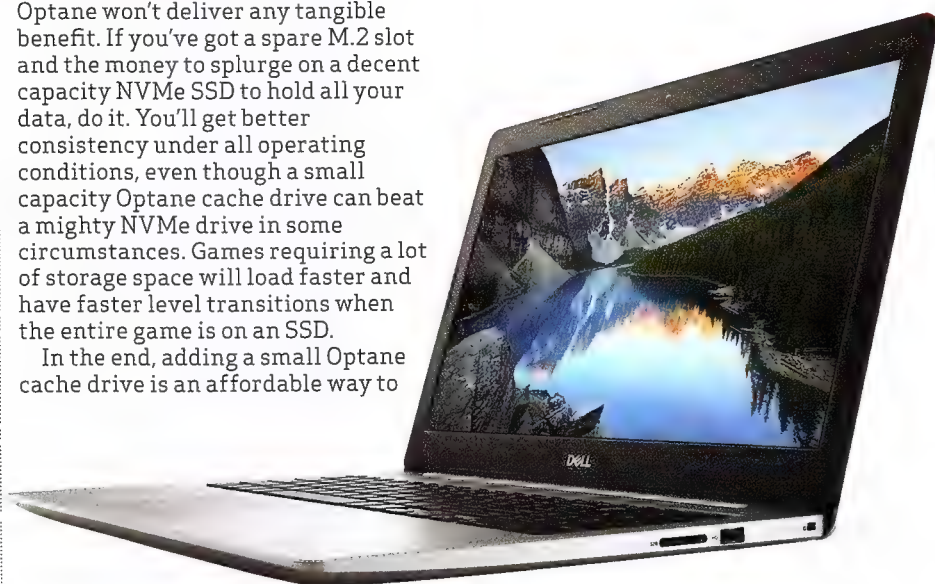
Of course, Optane caching isn't for everyone. If you've already got an SSD, Optane won't deliver any tangible benefit. If you've got a spare M.2 slot and the money to splurge on a decent capacity NVMe SSD to hold all your data, do it. You'll get better consistency under all operating conditions, even though a small capacity Optane cache drive can beat a mighty NVMe drive in some circumstances. Games requiring a lot of storage space will load faster and have faster level transitions when the entire game is on an SSD.

In the end, adding a small Optane cache drive is an affordable way to

speed up a system or laptop that's encumbered by a HDD. A high capacity SSD is ultimately still the way to go, but they cost a lot more than what a little Optane drive will cost. It's a terrific, and underappreciated way to give your system a truly tangible speedup without breaking the bank.

VERDICT

Adding an Intel Optane cache drive to your hard drive equipped PC or laptop provides an affordable and surprisingly tangible speedup. ■





LAPTOP

FROM \$1,499 | WWW.MICROSOFT.COM/EN-AU

Surface Laptop 2

Microsoft's professional clamshell resurfaces with Windows 10 and a new CPU.

The original Surface Laptop from Microsoft was a gallant first attempt in the professional ultrabook space, but it was too light on power to be useful for creatives and Windows 10 S was a bit restrictive for a professional laptop (it works much better on the new Surface Go 2-in-1 tablets). Fast forward a year however and Microsoft has transformed the Surface Laptop line from a promising category into a refined and on point device that meets all of our initial expectations.

The heart of the new Surface Laptop 2 is a quad-core Intel processor which starts with a Core i5-8250U (there's no Core m3 model this year) and ranges to include a Core i7-8650U (the same CPU on Microsoft's gaming-capable Surface Book 2 tablet). This power jump isn't just clear on paper, we pegged a 78% boost in multi-threaded CPU power on Cinebench

R15 from the last generation's i5 model. This means that instead of stumbling when running Windows 10 Pro (as the initial Surface Laptops did after upgrading from 10S) you can actually now fire up a photo editing suite with a few Chrome tabs open and you'll still have plenty of processing power left in the tank.

Other than the updated CPU not a lot has changed in the new Surface Laptop. Actually, that's an understatement; apart from a new Black colour scheme and the updated CPU, everything is identical to the original. It's got the same squarish aluminium chassis and uses the same soft Alcantara finish on the bottom inside edge. It occupies the exact same 30.8 by 22.3cm footprint, folds to the same 1.4cm maximum thickness and weighs an identical 1.252kg. It even uses the same 13.5-inch 3:2 PixelSense display at the same 2256 x 1504 pixel

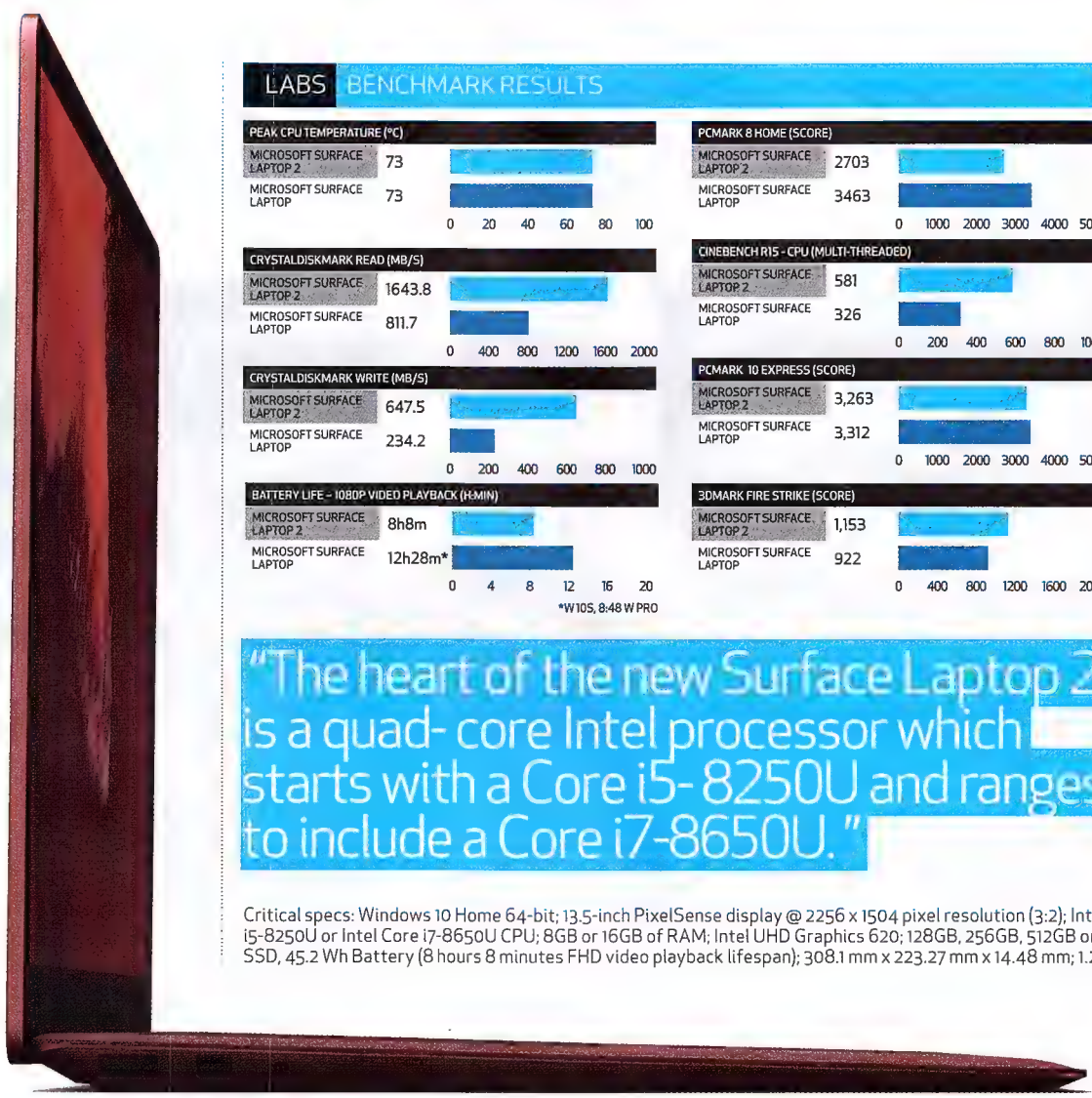
resolution. And yet, despite all this sameness, we couldn't be happier with it.

The responsive 1.5mm travel and subdued tap of the surface Laptop 2's keys makes it a joy to type on and the soft Alcantara keyboard surround and malleable beveled edge make it exceptionally comfortable to rest your palms on while typing. Marry this with a powdery and generously sized center trackpad and a perfectly weighted laptop hinge that makes the 10-point touch screen easy to adjust and yet sufficiently sturdy, and you have a laptop that is blissfully easy to use.

The Surface Laptop 2 keeps a standard Surface-like port configuration, omitting the USB Type-C port entirely. This seems to be a sticking point for many, but it's not really as big a deal as it gets made out to be. The Surface Pro 2's single USB 3.0 Type-A port, Mini DisplayPort and 3.5mm headphone jack are a good balance of essential

interface options that'll offer the easiest solution for 90% of the things you'll need to connect. If you absolutely need USB-C for an external monitor then you can purchase a Surface Port to USB-C Adapter for \$110 and if you want a full dock arrangement then Microsoft's Surface Dock offers an impressive selection of connections for just \$300.

The Surface Laptop 2 comes in 4 colours (Black, Burgundy, Cobalt Blue and Platinum), can be configured with either 8GB or 16GB of RAM, and offers 128GB, 256GB, 512GB or 1TB storage capacities. Whilst there are some additional limitations on configurations if you go for any colour other than Platinum, the 8GB RAM setup gives a choice of i5 or i7 CPU, with either a 128GB or 256GB storage capacity for a cost of \$1,499, \$1,999 or (i7) \$2,499. The 16GB RAM configuration only comes with a Core i7 CPU and either 512GB or 1TB of



LABS BENCHMARK RESULTS



"The heart of the new Surface Laptop 2 is a quad-core Intel processor which starts with a Core i5-8250U and ranges to include a Core i7-8650U."

Critical specs: Windows 10 Home 64-bit; 13.5-inch PixelSense display @ 2256 x 1504 pixel resolution (3:2); Intel Core i5-8250U or Intel Core i7-8650U CPU; 8GB or 16GB of RAM; Intel UHD Graphics 620; 128GB, 256GB, 512GB or 1TB PCIe SSD, 45.2 Wh Battery (8 hours 8 minutes FHD video playback lifespan); 308.1 mm x 223.27 mm x 14.48 mm; 1.25kg.

storage, for \$3,299 or \$3,999 respectively.

For reference a quad-core i5 MacBook Pro (2018) starts at \$2,699 with 8GB of RAM and 256GB of storage and you can get a 2018 Razer Blade Stealth with a Core i7, 16GB of RAM and a 512GB SSD for \$2,669. We've even seen a Dell XPS 13 (i7-8550U, 16GB, 512GB SSD) go for as little as \$2,209 on sale. So while the Surface Laptop 2's prices look good against Apple, they're pretty standard launch prices against any other competitor.

Microsoft has really locked down the thermals and processor of the Surface Laptop 2, with the CPU and GPU of the i5 model we tested keeping itself under 73° and 67° across all of our testing. Since this device is missing the usual 'Performance' or 'Balanced' power modes and all options for CPU

optimisation have been hidden, you can't push this CPU any further. We did see some issues with the 2017 Surface Pros maxing out at 97-100° (which is way too hot), but keeping a CPU below 73° at all times is an underutilisation of its full potential. That said, the core CPU performance results are roughly where they should be with the Surface Laptop 2 scoring within 15% (either way) of an identically specced Acer Spin 5 on Cinebench R15 CPU and HWBot's x265 media encoding benchmarks – even though the latter ran much hotter, spiking to 95°. So this is clearly an Intel thermal constraint rather than anything Microsoft is responsible for.

What was disappointing was that we saw PCMark 8 benchmark results that were 20% lower than last year's i5 Surface Laptop

results in the Home test. This result starkly contradicts our real world testing however, where the Surface Laptop 2 felt far snappier and more responsive than the original. That said, the lower clock speed, higher boost speed of the new i5-8250U has been reported to slow down over longer CPU tasks relative to its predecessor.

The model we tested had a 256GB Skhynix SSD that netted read and write scores of 1643.8MB/s and 811.7MB/s respectively. This aren't the fastest NVMe speeds we've come across, but it's two to three times faster than a SATA connected SSD. And whilst graphical performance isn't really a selling point of this device, we were able to get light games like *Rocket League* to run above 30fps in 1080p High Performance mode. That said, you'd

probably want to drop the resolution down little for better appearance overall.

The more efficient chip means battery life on the Surface Laptop 2 is better than the original under high intensity workloads. In PCMark 8's demanding Home battery benchmark the Surface Pro 2 lasted 6 hours and 7 minutes while its predecessor got just 4:47 hours. However when it comes to 1080p movie playback, the Surface Laptop 2 died 40 minutes earlier at 8 hours and 8 minutes. ■ Joel Burgess

Verdict

Microsoft may have only tweaked a few things on the Surface Laptop 2, but it's made a big difference.





Crucial P1 1TB NVMe SSD: M.2 2280 Form Factor; Micron 64-Layer 3D QLC NAND; PCIe 3.0 x4 Interface; Silicon Motion SM2263EN Controller; 1GB DDR3 Cache; Up to 2000/1700 MB/s Sequential Read/Write; Up to 170K/240K Read/Write IOPS; 200 TBW Endurance; 5 Year Warranty

NVME SSD
\$330 | WWW.CRUCIAL.COM

Crucial P1 1Tb M.2 SSD

Crucial finally enters the NVMe SSD market.

NVMe SSDs have been available for years now, many of them featuring Micron NAND flash memory. Curiously, Micron has not released NVMe drives under its own Crucial brand until now. We have high expectations given Crucial's track record and reputation for value. Can it shake up the market like it did with the excellent MX500 series?

The Crucial P1 is a typical NVMe M.2 2280 (80mm length) drive that makes use of a PCIe 3.0 x4 interface. The drive contains Micron's 64-Layer QLC NAND. Quad-level cell NAND stores four bits per cell. This means more data can be stored per die, in turn leading to higher capacities and/or cheaper prices. While QLC NAND should lead to lower SSD pricing, it does have some drawbacks. Performance favours TLC-equipped drives and

even more so a drive like the Samsung 970 Pro which uses MLC (2 bits per cell). Endurance also suffers. The 1TB P1 is rated for 200 terabytes written, this is also some way below TLC drives. While regular users won't face any issues using a QLC drive for many years, professionals and users who thrash their drives with heavy I/O will prefer hardware with higher endurance ratings.

The 1TB Crucial P1 uses a Silicon Motion SM2263 controller. It's a more budget-oriented controller that won't produce the performance we see on top of the line NVMe SSD's. That's ok though, as the aim is to keep the price of the drive down. Performance is officially rated at 2000 MB/s for sequential read and 1700 MB/s for sequential write performance. This is much faster than any SATA SSD,

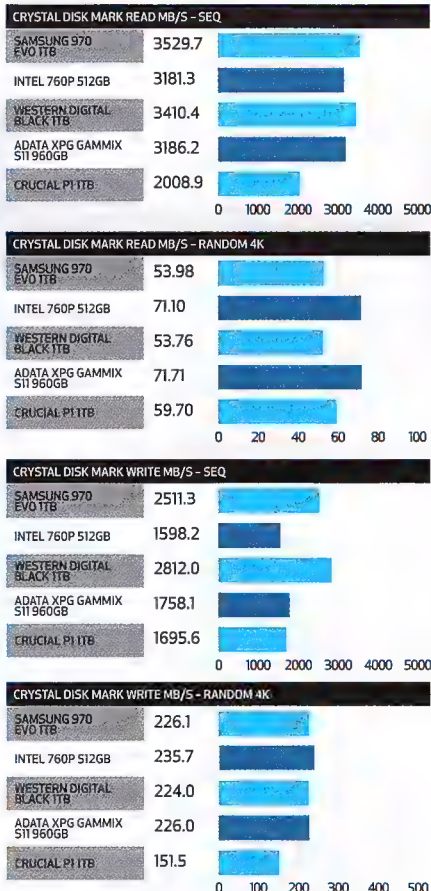
but some way below the top of the range drives. The P1 doesn't come with any drive encryption capability. You do get the common SSD features including TRIM, garbage collection, S.M.A.R.T. and a welcome five-year warranty. Crucial offers a link to Acronis True Image cloning software which is a nice piece of software for upgrading from your existing drive.

As a budget oriented drive, we didn't expect any record setting performance from the P1 and our results were pretty much mediocre, even though it 'feels' snappy enough during regular testing and day to day use. Random read speeds are characteristically strong with SM2263 controllers and we see this again with the Crucial P1. In all other areas though, it does lag behind. In day to day use you won't notice much difference, but under heavy load you will. As expected,

performance does drop off once the cache is saturated under heavy sustained load.

The P1 is a welcome market entry from Crucial, however given its lacklustre performance, it needs to be priced competitively in a cut throat market. Unfortunately this is where it falls down. At the time of writing, the P1 was selling for around \$330 for the 1TB model, putting it a good \$30 above the excellent Samsung 970 Evo. This makes recommending the Crucial P1 impossible unless it gets a major price cut. ■ Chris Szewczyk

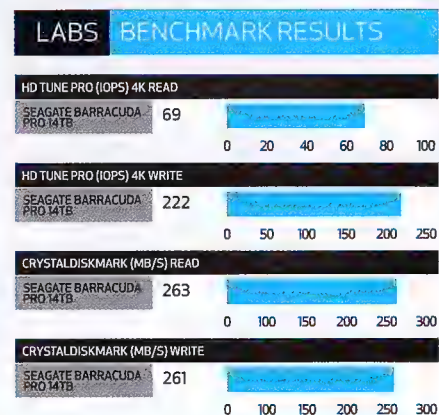
LABS BENCHMARK RESULTS



Verdict

The Crucial P1's mediocre performance and high pricing leave it with a big disadvantage in a very tough market.





HDD

\$979 | WWW.SEAGATE.COM/AU

Seagate BarraCuda Pro 14TB

Massive storage for regular desktop PCs.

The exponential increase in data storage requirements over the last decade or so has been handled by regular increases in hard drive capacities. Multiple HDD vendors supply them to cloud providers (who get the main benefits from advancements in hard drive technologies), but, Seagate is the only one to also focus on the home consumer/prosumer market. In the last three generations, we have seen that Seagate has been the first to target the desktop storage market with their highest capacity drives. The 10TB BarraCuda Pro was released in Q3 2016, and the 12TB version in Q4 2017. Now from Seagate we have the 14TB model.

The Seagate BarraCuda Pro 14TB is a 7200RPM SATAIII (6 Gbps) hard drive with a 256MB multi-segmented DRAM cache. It features eight PMR platters with a 1077 Gb/in2 areal density in a sealed enclosure filled with helium. The main

change compared to the 12TB version introduced last year is the usage of Seagate's second-generation two-dimensional magnetic recording (TDMR) heads, allowing for higher areal density (1077 Gb/in2 vs. 923 Gb/in2 without TDMR).

According to Seagate, the 14TB BarraCuda Pro typically draws around 6.9W, making it one of the most power efficient high-capacity 3.5-inch hard drives in the market. It targets creative professionals with high-performance desktops, home servers and/or direct-attached storage units. It is meant for 24x7 usage (unlike traditional desktop-class hard drives) and carries a workload rating of 300TB/year, backed by a five year warranty. The drive also comes with a bundled data-recovery service (available for two years from date of purchase).

Random accesses are never the strong points of hard drives, and we see that the BarraCuda Pro delivers around 69 IOPS for 4K random reads and 222 IOPS

for 4K random writes. The random read performance is very similar to the performance of the 12TB version from last year, while the random write performance receives a boost up from 191 IOPS.

Consumers opting for drives such as the 12TB Seagate BarraCuda Pro typically need high-capacity local storage for holding and editing/processing large-sized multimedia files. The 14TB BarraCuda Pro came in with a sequential read of 263MB/s and 261MB/s sequential write. The numbers are in the same ballpark as the 12TB version from last year. These numbers are better than the ones we obtained for the 10TB version from 2016, but, fall a little short of the performance of the 12TB drive from last year. The temperature of the unit at the end of the transfers (more than 250GB of traffic) rose by less than 4°, pointing to the power-efficiency of the platform.

Desktop hard drives are typically not rated for 24x7

operation, but, the BarraCuda Pro series bucks that trend. In addition to a 300TB/yr workload rating, Seagate also provides a five year warranty and, with product registration, two years of data recovery services.

Similar to the 10TB and 12TB versions that we had evaluated in the last couple of years, the 14TB version leaves very little to complain about. It doesn't deliver any marked performance improvements over either the 10TB or the 12TB versions released in the previous years. However, it does enable users to have more local / direct-attached storage per 3.5-inch drive bay than ever before at consumer price points. ■ Ganesh TS

Verdict

Better value than its predecessor along with better endurance ratings than other consumer flash-based SSDs.





CPU

2920X \$999, 2970WX \$1,999 | WWW.AMD.COM



AMD RYZEN THREADRIPPER 2920X
12nm; Socket TR4 (X399 Chipset); 12 cores/24 threads; 3.5 GHz base clock, 4.3 GHz max boost clock, supports up to DDR4-2933, 32MB L3 Cache; 64 PCIe lanes; 180W TDP



AMD RYZEN THREADRIPPER 2970WX
12nm; Socket TR4 (X399 Chipset); 24 cores/48 threads; 3.0 GHz base clock, 4.2 GHz max boost clock, supports up to DDR4-2933, 64MB L3 Cache; 64 PCIe lanes; 250W TDP

AMD Ryzen Threadripper 2920X and 2970WX

Unprecedented levels of desktop computing power.

AMD came roaring back into the HEDT market with the release of first generation Threadripper processors in mid-2017, topped by the 16 core 1950X. 16 cores was just a tease though as the 1950X used only two of the four dies present. This design left open the possibility that we'd eventually get a full 32 core option, which is exactly what we got with the release of the 2990WX a couple of months back.

Now we have the final two second-generation Threadripper models making their debut. The 2970WX is a 24 core/48 thread CPU. It's joined by the 12 core/24 thread 2920X, which promises a good blend of single and multi-threaded grunt and is more accommodating of 2018 consumer-level software and Windows scheduling. In many ways Threadripper is ahead of its

time. Apps with the appropriate threading support simply thrive, but the problem remains; many apps just can't make use of all the multithreading power on hand.

ZEN+ AND 12NM REFINEMENTS

Second generation Ryzen processors carry all the improvements introduced with second generation Ryzen earlier in 2018. The improved 12nm process leads to better power efficiency and increased frequencies. Add in lower cache latencies and improved memory support and we also get better performance clock for clock. The maximum official memory support has been increased to DDR4-2933.

Threadripper 2 is supported by all existing X399 motherboards after a BIOS update, negating

the need for an additional motherboard purchase. X399 motherboards pack in a great set of features, perhaps most noteworthy being the availability of 64 PCIe 3.0 lanes. This means there's enough bandwidth on hand to handle multi GPU systems or complex SSD arrays without having to consult the motherboard manual to see what works if you add this or install that.

RYZEN MASTER IS PARTICULARLY IMPORTANT

Ryzen Master is AMD's control app. It closely resembles the Radeon driver control panel. It packs in a heap of tweakable settings and monitoring information. Most users will still use the BIOS for serious tweaking, but Ryzen Master has a particularly important toggle that you should use if you are gaming: Game

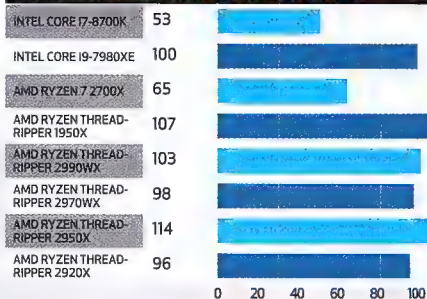
Mode. As many game engines simply cannot handle very high core counts, Game Mode, or Legacy Compatibility Mode, disables ½ or ¾ of the available cores. To get the best gaming performance out of Threadripper, you really should enable Legacy Compatibility Mode as even 16 cores can present some problems for game engines.

MULTI THREADING DOMINANCE

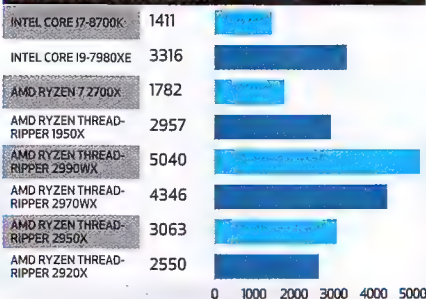
As we expected, Threadripper CPUs dominate heavily threaded benchmarks. The WX models in particular laugh off even the mighty Intel i9-7980XE. Apps that support very high core counts perform magnificently. As we see though, many apps just cannot deal with high core counts. We tested a new benchmark called

LABS BENCHMARK RESULTS

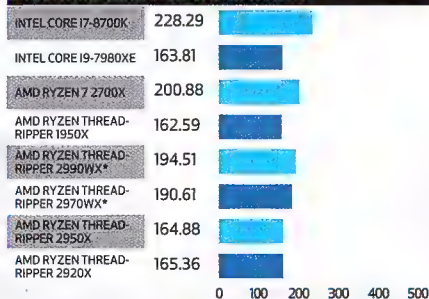
CINEGY CINESCORE VIDEO ENCODING - AVC ULTRA 400 2160P FPS



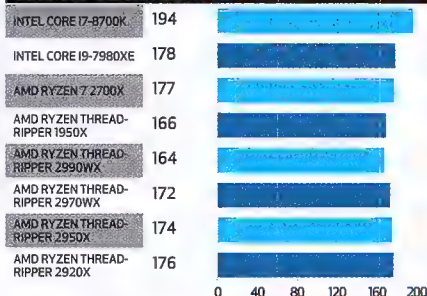
CINEBENCH 15 - MULTI-THREAD SCORE



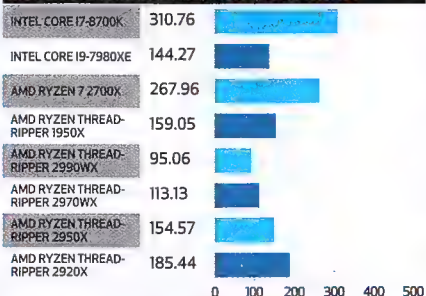
RISE OF THE TOMB RAIDER - 1080P LOW, DX12, AVG FPS



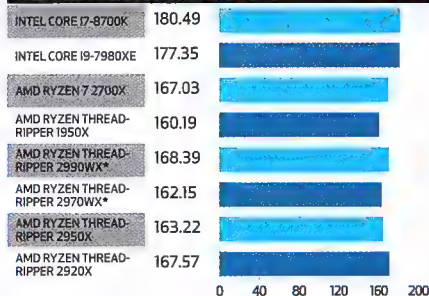
CINEBENCH 15 - SINGLE-THREAD SCORE



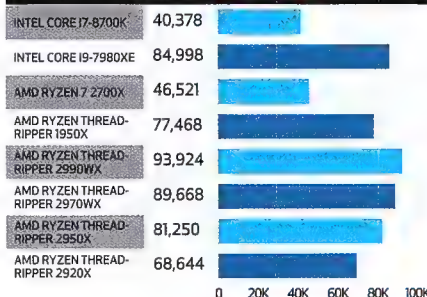
BLENDER 2.79 BMW RENDER - TIME (SECONDS) LOWER IS BETTER



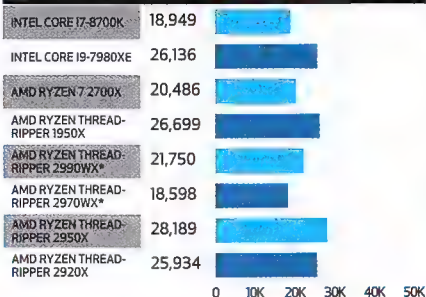
GHOST RECON: WILDLANDS - 1080P LOW, AVG FPS



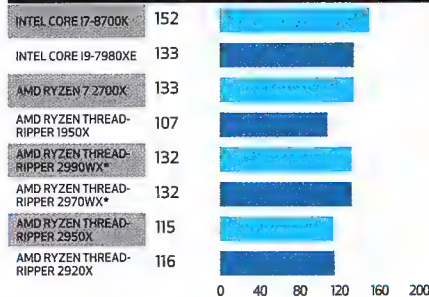
7ZIP - MILLION INSTRUCTION PER SECOND



3DMARK FIRESTRIKE - PHYSICS SCORE



FARCRY 5 - 1080P LOW, AVG FPS



*LEGACY MODE

"Under load, the 2970WX never even hit 70° with all 24 cores and 48 threads at 100% load. The 2920X was even better, barely cracking 60°."

Cinegy Cinescore. It too fails to scale over 16c/32t.

Gaming is a real mixed bag. Initial testing gave some very strange results with the WX models in particular, showing that some game engines all but break with very high core count CPUs. To counter this, we enabled the Legacy Game Mode in the Ryzen Master software. Doing this mostly brought the WX models into line with the 2700X. Outright gaming performance still favours Intel, but remember the gap is basically nothing at high resolution and image quality settings where the load switches back to the GPU.

Threadripper CPUs run remarkably cool, staying in the low 30's when at idle. Under load, the 2970WX never even hit 70° with all 24 cores and 48 threads at 100% load. The 2920X was even better, barely cracking 60°. It's clear that Threadripper's individual dies, soldered heatspreaders and large cooling contact areas make a huge difference.

CAN YOU MAKE USE OF ALL THE MULTI-THREADED GRUNT ON HAND?

The 2970WX is an absolute monster just like its big brother 2990WX, but only if you use software that can

take advantage of all the parallel power on hand. If you don't use applications that support highly multithreaded workloads, then the WX series CPUs are very much overkill.

The 2920X with its 12 cores offers a good blend of multi-core power, but in a more 2018 consumer friendly package. If you find yourself doing a frequent mix of tasks, then it's a terrific CPU. Regular users and gamers are still better off with the mainstream platforms though. Not that they're aimed at regular users. Threadripper is all about providing unprecedented levels of desktop

computing power. If you can make use of that power, they become very compelling options indeed.

Chris Szewczyk

Verdict

The Threadripper 2920X and 2970WX provide massive parallel processing power that requires appropriate software support to fully utilise.

AMD RYZEN THREADRIPPER 2920X



AMD RYZEN THREADRIPPER 2970WX



NVIDIA GTX 2070

Is this GPU poised to be the new price/performance gaming king? Chris Szewczyk is in the Labs to find out.

Back in September this year, Nvidia's RTX 2080 and RTX 2080 Ti made their long-awaited debut. While we were impressed with the cards and their forward-looking technologies, their high prices were definitely a downer. The GeForce RTX 2070 goes some way to addressing that, though the cheapest versions are still well over \$800, leaving RTX 2070s priced too high to unequivocally recommend compared to the previous Pascal generation. For now though, the RTX 2070 is the cheapest way to jump onboard the Turing train.

Nvidia has departed from its recent tradition of equipping the x70 card with a cut down variation of the GPU found in the x80 version, like we saw with the GTX 970 and 980, and GTX 1070 and 1080. This time the RTX 2070 makes use of an entirely separate GPU, the TU106. This is a significantly smaller GPU than the TU104 found in the RTX 2080, helping Nvidia save on manufacturing costs. It also gives Nvidia more freedom to release other SKUs in the future. Who wants to bet that we'll see a RTX 2070 TI using a cut down TU104 and RTX 2060 Ti using a cut down TU106?

The RTX 2070 makes use of the full TU106 die without any disabled features. It comes with 2,304 CUDA cores, 288 Tensor cores and 36 RT cores. It makes use of 8GB of GDDR6 memory over a 256-bit bus, identical to the RTX 2080. Power consumption has risen compared to the GTX 1070, but on the other hand, it's reasonably thrifty compared to the 215-225w of the RTX 2080. Note that the RTX 2070 doesn't have and NV-Link or SLI fingers as it's not supported.

The Tensor and RT cores are at the heart of what Nvidia is trying to achieve with Turing. Tensor cores are designed to accelerate AI and deep-learning applications. We're yet to see how these cores will impact gameplay though we're impressed with Deep-Learning Super-Sampling (DLSS) which delivers very high quality AA levels without taxing the GPU the way traditional AA does. The RT cores are obviously used for ray tracing applications. There are a few demos on the web that are well worth checking out to see just how gorgeous some of the new technologies are. There are plenty of games coming that make use of RTX features including *Battlefield V* and *Metro Exodus*.

While a lot of the forward looking features are very impressive, their real world performance is still largely unknown. The previous generation GTX 1000 series cards still offer tremendous gaming performance, making a card like the RTX 2070 a side-grade for some users. Time will tell if the RTX 2070 matures like a fine wine. We hope we'll see all that potential put to good use.

We've got our hands on a selection of RTX 2070 models from Asus, Gigabyte and MSI. They are joined by the rarer RTX 2070 Founders Edition. Read on as we take a look at what may be the most important RTX model of all.



GRAPHICS CARD

#999 | WWW.NVIDIA.COM.AU

Nvidia GeForce RTX 2070 Founders Edition

A surprisingly compact RTX 2070.

High end graphics cards have generally trended upwards in size. Triple slot cooling and PCBs protruding well above the PCIe bracket are the norm. With this in mind it's a real surprise to see just how compact the RTX 2070 Founders Edition is. Small doesn't mean cheap and ineffective though. We were pleasantly surprised at how much of a jump in quality the RTX 2080 and 2080Ti Founders Edition cards were over their predecessors. At a glance the RTX 2070 Founders Edition looks like a good step forward too.

From the outside, the RTX 2070 Founders Edition looks like a compact version of its big brothers. Gone is the old noisy blower cooler. In its place is a totally redesigned

cooler featuring twin 8.5cm axial fans blowing down into a fin array. Users who miss the old blower cooler still have 3rd party options to choose from. The card is surrounded by an aluminium shroud that assists with cooling, as well as providing structural rigidity to the card.

The top of the card features the usual GeForce RTX logo, but of course there's no NV-link connector available, as the RTX 2070 doesn't support it. The 8-pin power connector is moved to the side of the card, which helps with cable management and gives a cleaner look if it's to be shown in a windowed case.

The RTX 2070 Founders Edition offers two DP 1.4 connectors, a single HDMI 2.0b, and somewhat surprisingly in 2018, a

DVI-DL port. The PCB is adequate, but nothing more. A basic 6+2 phase VRM powers the GPU and GDDR6 memory. If you're looking to extract the maximum from the TU106 GPU, then the aftermarket cards with custom PCBs offer a significant step up in component quality. As it is though, the Founders Edition gets the job done and will appeal to users who don't need their GPU to come with the kitchen sink.

The Founders Edition can't match the boost clocks of the custom cards but getting within a few percent despite the compact cooler's handicap is still admirable. It can even game at 4K making it a compelling compact option for a lounge room gaming PC. The card isn't noisy either.

The RTX 2070 Founders

Edition is a good step forward in terms of thermals and acoustics compared to the old blower style cards. While the 2070 is a good card, there's no doubt that pricing remains a negative and takes away some of the excitement we usually have when reviewing new high-end GPUs. We'll have to revisit the whole RTX 2000 series once the technology sees widespread use. Here in late 2018, the RTX 2070 is still a very capable gaming card but if you're playing on a GTX 1080 or higher, the Founders Edition seems like more of a side-grade. For everyone else, the RTX 2070 is a very fast GPU, perfect for high quality 1440P gaming.

Verdict

Vastly improved cooling over the last FE cards, but conservative clocks hold it back.



Nvidia GeForce RTX 2070 Founders Edition, 2304 CUDA Cores, 1410MHz Base Clock, 1710MHz Boost Clock, 8GB GDDR6 14Gbps memory, 448GB/s Memory Bandwidth, 3x Display Port 1.4, 1x HDMI 2.0b, 1x DVI-D, 1x USB Type-C, 1x 8-Pin Power Connector, 185W TDP



GRAPHICS CARD

\$1,199 | WWW.ASUS.COM.AU

Asus ROG Strix GeForce RTX 2070

A high end RTX 2070 with a price to match.

The ROG Strix 2070 is the flagship Asus 2070 offering. The bar is always set high for any ROG product and if you take one look at the ROG Strix 2070 you'll know it's a premium offering. It packs in a premium PCB, a beefy cooler and plenty of unique ROG features. The competition is tough though and the Asus has a significant price premium that needs to be justified.

The Strix 2070 is outwardly similar to the other Strix RTX cards. The build quality is superb with a large brushed aluminium back plate that's enhanced by an RGB-lit ROG logo. There's also a large PCB baseplate that helps to cool the components while offering additional rigidity. The shroud features some

RGB highlights around the fans while the ROG logo on the side of the card is also lit.

The cooler is a triple fan design. Like many cards these days, it's effectively a triple slot cooler. Asus uses custom designed axial fans to increase static pressure which is a good thing with dense fin heatsinks. Like most coolers these days, the fans stop when the card is idle, only spinning up when the card reaches a temperature threshold.

The PCB of the Strix 2070 is particularly impressive. A 10 Phase VRM is present, easily capable of powering the not-too-thirsty TU106 GPU. There's also a pair of fan headers present which are very useful for controlling adjacent case fans. An additional RGB header can be controlled via Asus' Aura Sync app. If you're

not crazy about RGB though, there's a handy switch to turn it off if you prefer. Other features include voltage read points and a BIOS switch to change between quiet and performance modes.

Asus has deviated from the standard RTX 2070 video outputs. Gone is the DVI-D connector and one of the DisplayPorts. We have a pair of DP 1.4 connectors, 2x HDMI 2.0b and a USB Type-C port. The inclusion of dual HDMI is a good thing for those who plan to use a VR headset.

Performance-wise, the Strix 2070 performed notably better than the Founders Edition but we did note that it ran just a couple of degrees warmer than the Aorus and MSI cards, which meant its maximum boost clock fluctuated a tiny bit

more. The Strix cooler is very quiet indeed and we simply couldn't hear it over the fans from our AIO CPU cooler.

The Asus ROG Strix 2070 is an excellent 2070 offering that crams custom features into a very well built package, but when it costs over \$100 more than its high-end competitors, it's tough to recommend. When the supply settles and pricing stabilises, by all means take a look at the Asus Strix 2070. It's an excellent and particularly quiet card with some unique features that that reinforces the reputation we've come to expect from Asus ROG.

Verdict

The Asus Strix is an excellent GTX 2070 but strong competition leaves it in a tough spot with its hefty price premium.



Asus ROG Strix GeForce RTX 2070 Gaming, 2304 CUDA Cores, 1410MHz Base Clock, 1845MHz Boost Clock, 8GB GDDR6 14Gbps memory, 448GB/s Memory Bandwidth, 2x Display Port 1.4, 2x HDMI 2.0b, 1x USB Type-C, 1x 8-Pin & 1x 6-pin Power Connectors



GRAPHICS CARD

\$1,079 | WWW.GIGABYTE.COM.AU

Gigabyte Aorus GeForce RTX 2070 Xtreme

A 2070 that's truly blinged out.

The Gigabyte Aorus 2070 Xtreme really is a bit different. In addition to a custom PCB, factory overclock and hefty triple fan cooler, the Aorus Xtreme manages to pack in seven(!) video outputs and comes with a spectacular RGB implementation.

We knew we were looking at something different the moment we took the Aorus 2070 Xtreme out of its box. Gigabyte calls its new cooler the Windforce Stack 3x. It utilises three 100mm double ball bearing fans that spin in alternate directions. The cooler's shroud is also interesting. Most GPU coolers are quite closed but the 2070 Xtreme features a wide open shroud that should theoretically be better for heat dissipation.

Normally we wouldn't

devote too much time to talking about RGB, but this card demands it. It's spectacular and needs to be shown off in a vertical position inside a windowed case. What makes it so visually striking is it's the fans themselves that have RGB LEDs. There's a complete range of effects to choose from. Beware you may find yourself looking at the Aorus Xtreme 2070 instead of your monitor! We'd go as far as to say it's the best RGB implementation of any graphics card we've ever seen. It's not all about bling though. The Windforce Stack 3x cooler is able to maintain its boost clocks at high levels, while remaining effectively silent. If you keep it cool enough, it will boost over 1900MHz. Impressive!

The card features a fully customised PCB with a 10+2

phase VRM. It's powered by 6-pin and 8-pin PCIe power connectors. The memory chips and MOSFETs are cooled by their own heatsink plate and there's a full cover back plate (with RGB of course) that assists with component cooling.

The Aorus 2070 Xtreme performed well during our testing. It's a good jump ahead of the already overclocked 2070 Founders Edition and performs on par with the other custom cards we covered. It provides great performance at 1440p even at high refresh rates and is capable of 4K gaming.

The other unique feature among our tested cards is the array of video ports. While Gigabyte states that you can only use five at one time, it's great to have this kind of flexibility. You can use 3x HDMI + 1x DP and the USB or

3x DP, 1x HDMI plus the USB. The 3x HDMI mode would be particularly useful for users rocking a VR headset, plus a HDMI TV and a monitor or two, all at the same time.

We like to spend most of our time looking at the monitor when gaming, but the Aorus 2070 Xtreme kept drawing our attention! If you're looking for a card to show off, this is definitely the one to get. It's far from a one trick pony though. It performs admirably while staying cool and quiet. Gigabyte also offers a four year warranty. Combine all this with a decent price and the Aorus 2070 Xtreme is easy to recommend.

Verdict

Gigabyte's Aorus RTX 2070 Xtreme is a gorgeous looking card that offers great performance and cooling capability.



Aorus GeForce RTX 2070 Xtreme, 2304 CUDA Cores, 1410MHz Base Clock, 1815MHz Boost Clock, 8GB GDDR6 14Gbps memory, 448GB/s Memory Bandwidth, 3x Display Port 1.4, 3x HDMI 2.0b, 1x USB Type-C, 1x 8-Pin & 1x 6-pin Power Connectors



GRAPHICS CARD

\$1,069 | WWW.AU.MSI.COM

MSI GeForce RTX 2070 Gaming Z 8G

RTX 2070 turned up to 11.

Comparing the RTX 2070 Founders Edition to the MSI RTX 2070 Gaming Z is almost like comparing a Tonka truck to a Hummer. The MSI is a huge card that positively dwarfs the Founders Edition.

The Gaming Z is MSI's highest tier of Gaming card, surpassed only by the limited edition OC focused Lightning series. It comes with an out of the box boost clock of 1830MHz. This is a big jump over the Founders Edition card, though it does come with a power consumption penalty as MSI states the 2070 Gaming Z can use up to 225W. To put that into perspective, that matches the RTX 2080 Founders Edition power consumption. The PCB is a fully custom design featuring an 8+2 phase VRM

all cooled via thermal pads.

Its physical dimensions mean that some consideration needs to be given with regards to the case it will go into. At 307x155x50mm, it's a big triple slot card but also very tall. It has a lovely brushed metal backplate that assists with cooling while looking great as well. There's a large metal support plate attached to the PCIe bracket that doubles as a RAM cooling plate while also adding rigidity to the card, preventing any sagging. It certainly needs it! The Gaming Z features a fairly typical complement of three DP 1.4 ports, a HDMI 2.0b port and the Type-C USB port. It is powered by 6-pin and 8-pin PCIe power connectors.

The MSI RTX 2070 Gaming Z features the latest Twin

Froze cooler that MSI has been continually refining. Now in its 7th iteration, the latest version uses two very large double ball bearing fans that do not spin up at all when the card is idle. The shroud features a healthy adornment of RGB lighting as is standard among all high-end graphics cards in 2018.

The MSI was able to boost to very high levels beyond the official boost clock. The monstrous cooler meant the MSI was able to consistently deliver the best performance out of all the 2070's we tested (even if the margin is tiny). If a GPU cooler can keep a card cool and maintain a very high boost clock while staying effectively silent, then it's doing its job very well. The MSI Twin Froze 7 does just that.

MSI has taken the TU106

GPU and given it the full aftermarket treatment. It's marginally the fastest 2070 we tested and it's also pretty good value. It's still quite a jump in price over the budget oriented 2070s though (if there is such a thing). Whether the bells and whistles are worth the extra money is up to you and the state of your bank balance. MSI has carved a strong reputation for itself thanks to a long line of highly recommended graphics cards and the RTX 2070 Gaming Z adds to that reputation. It extracts the maximum power from the RTX 2070 GPU.

Verdict

The MSI RTX 2070 Gaming Z wrings the neck of the TU106 GPU, extracting the maximum performance possible.

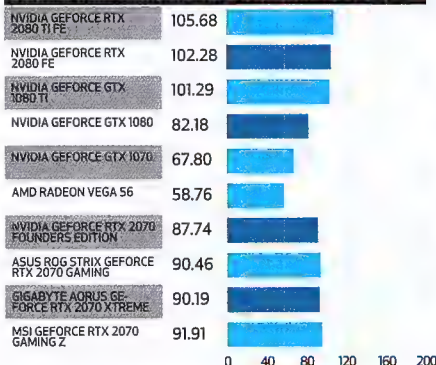


MSI GeForce RTX 2070 Gaming Z, 2304 CUDA Cores, 1410MHz Base Clock, 1830MHz Boost Clock, 8GB GDDR6 14Gbps memory, 448GB/s Memory Bandwidth, 3x Display Port 1.4, 1x HDMI 2.0b, 1x USB Type-C, 1x 8-Pin & 1x 6-pin Power Connectors, 225W TDP

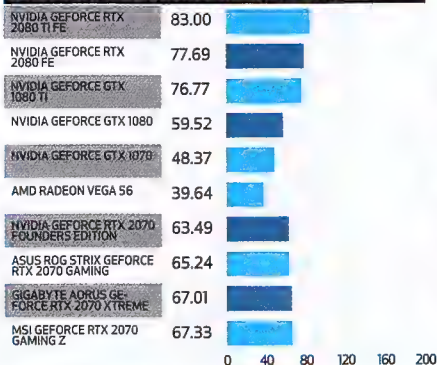
"While a lot of the forward-looking features are very impressive, their real world performance is still largely unknown. The previous generation GTX 1000 series cards still offer tremendous gaming performance, making a card like the RTX 2070 a side-grade for some users."

LABS BENCHMARK RESULTS

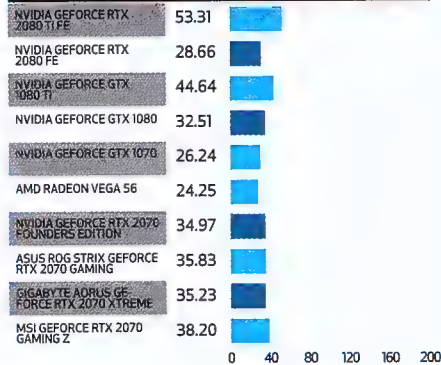
GHOST RECON WILDLANDS (VERY HIGH PRESET) - 1920X1080 - MIN



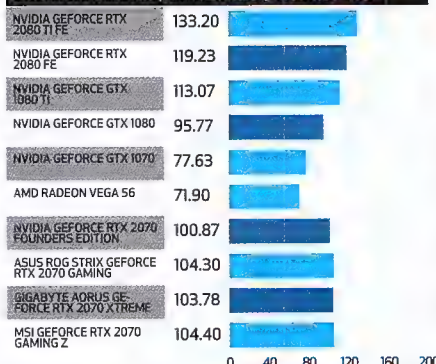
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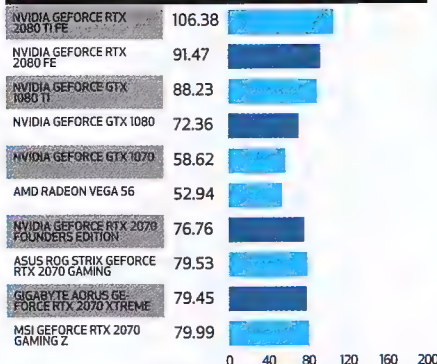
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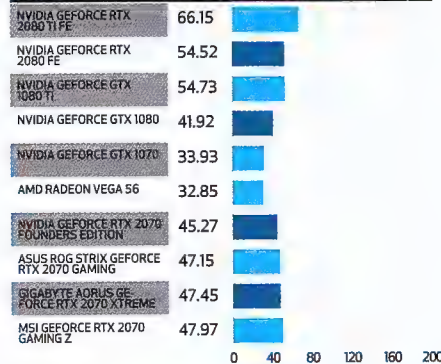
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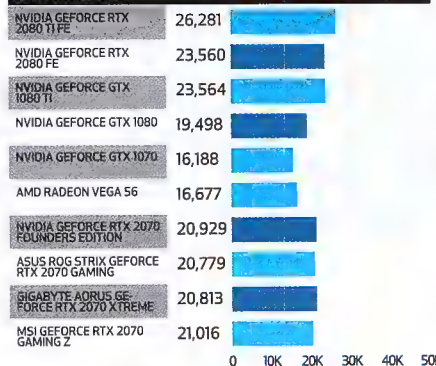
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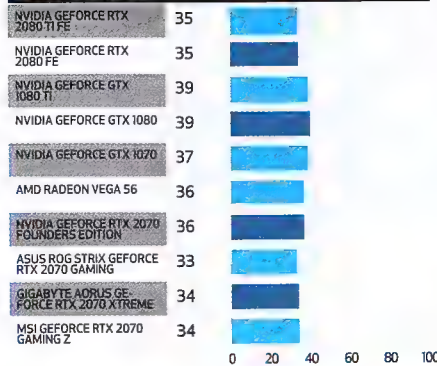
GHOST RECON WILDLANDS (VERY HIGH PRESET) - 3840X2160 - AVG



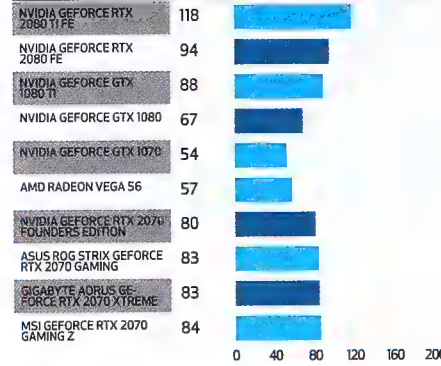
3DMARK FIRESTRIKE



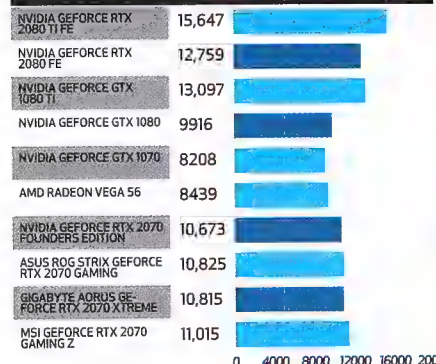
TEMPERATURES °C - IDLE



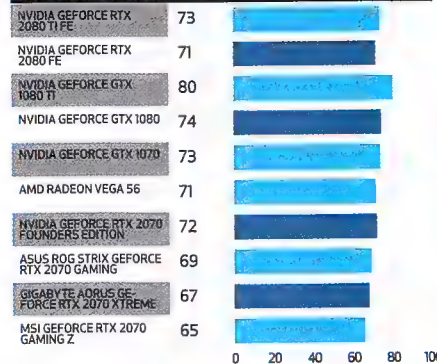
SHADOW OF WAR (ULTRA PRESET) - 2560X1440 - AVG



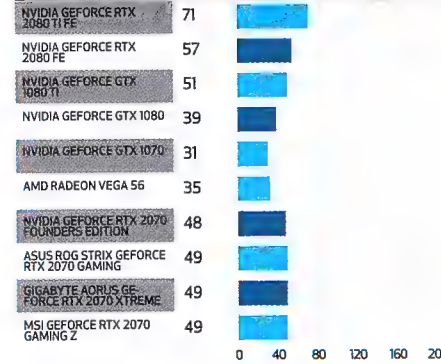
3DMARK FIRESTRIKE EXTREME

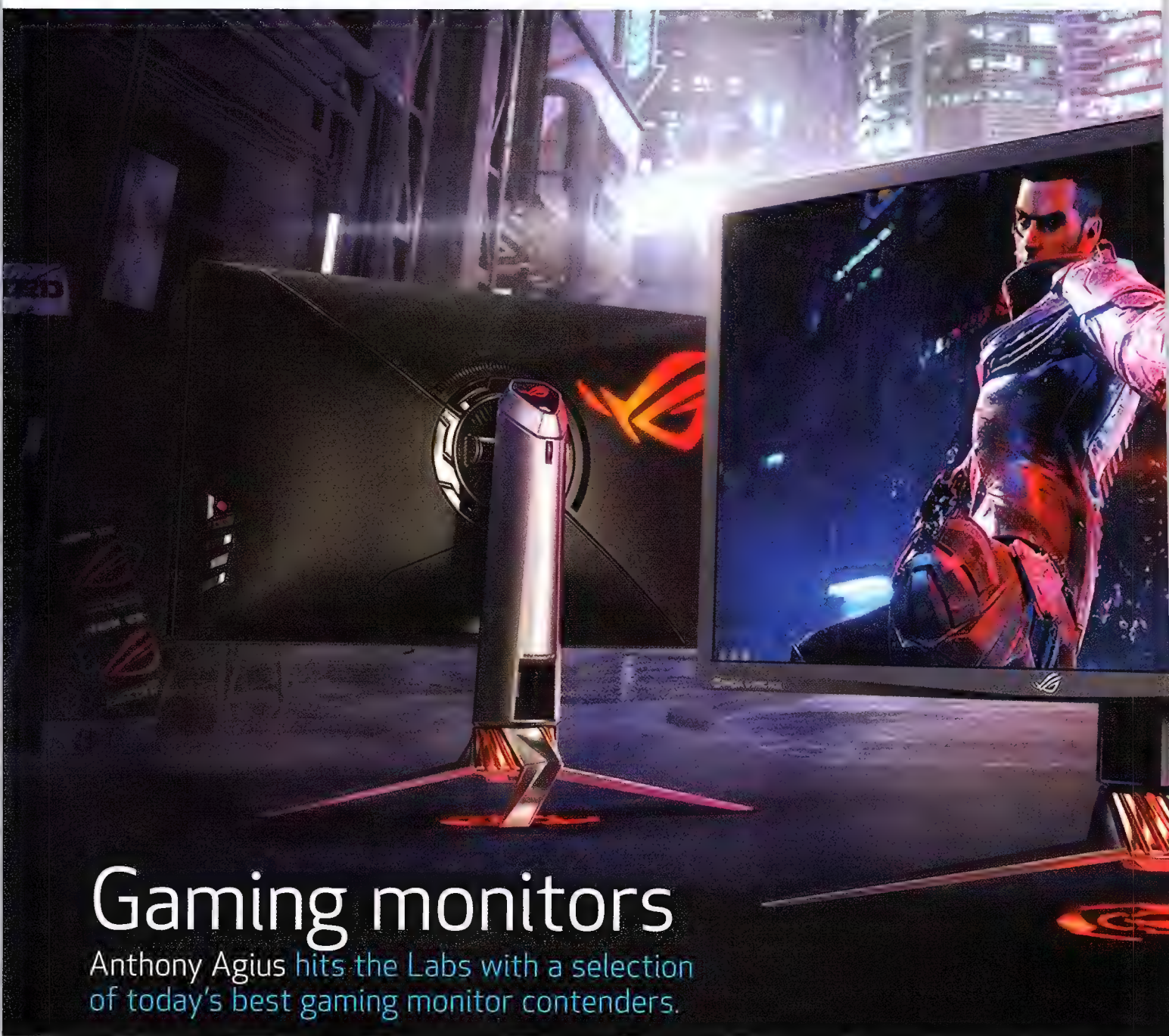


TEMPERATURES °C - LOAD



SHADOW OF WAR (ULTRA PRESET) - 3840X2160 - AVG





Gaming monitors

Anthony Agius hits the Labs with a selection of today's best gaming monitor contenders.

There's no point dropping thousands of dollars on a sweet gaming rig, only to pair it with a basic monitor that can't show off the full capabilities of the machine you spent all that money on. A quality monitor is essential for getting the best out of your gaming experience and the right purchase can last you many years and be attached to many GPUs over that time.

In 2018 there's a plethora of self-declared gaming monitor choices, in every price range you can imagine. Monitors starting at \$150 that reckon they're good for gaming and other monitors that will set you back

thousands are also gaming centric. What's the go then? What should you get to make sure it'll be useful for years to come?

WHAT TO LOOK FOR

If you're in the market for a gaming monitor, you want to ensure that your shopping list includes monitors meeting the following requirements:

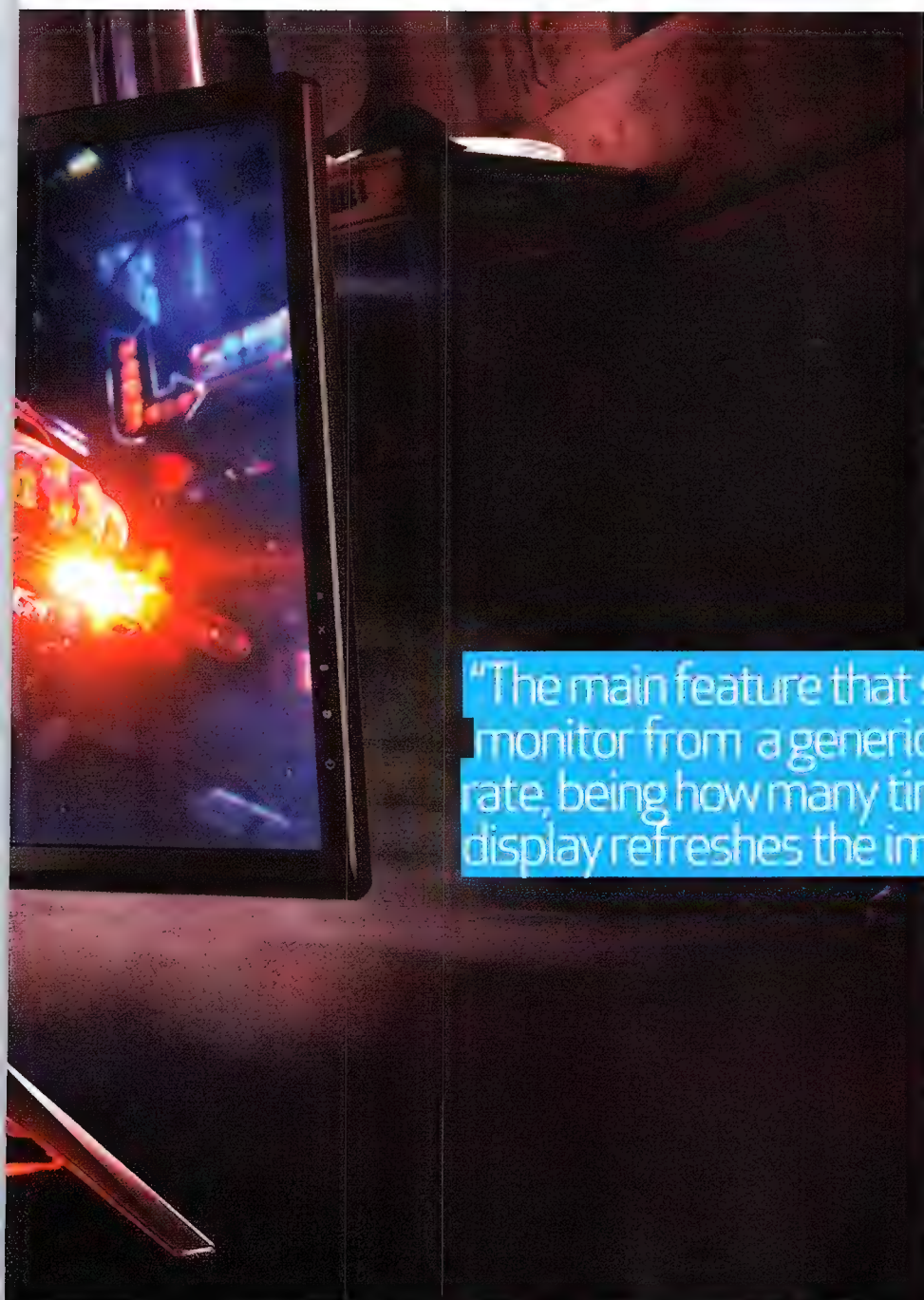
- High refresh rates for silky smooth gameplay.
- A resolution your GPU can handle at a display size you're comfortable with.
- Low response time to avoid image ghosting in fast-paced action scenes.

- FreeSync or G-Sync, depending on your GPU manufacturer.
- An LCD panel type that suits your needs.
- HDR support for future proofing.

Let's look at all the gaming monitor criteria in detail so you make the right choice!

REFRESH RATE

The main feature that separates a gaming monitor from a generic monitor is refresh rate, being how many times per second the display refreshes the image on the screen. This number is important to gamers as the higher the refresh rate, the



"The main feature that separates a gaming monitor from a generic monitor is refresh rate, being how many times per second the display refreshes the image on the screen."

smoother game play appears.

First person shooters are the predominate game that benefits from a high refresh rate. The human eye detects motion by blurring together still images, like a cartoon flip book. The faster these still images appear on screen, the less blurring, making enemies more discernible and potentially, easier to hunt and kill. 60Hz is the bare minimum refresh rate for smooth gaming and once you go above 120Hz, the benefits diminish for most ordinary people. Professional e-Sports gamers swear by their 240Hz displays.

A higher refresh rate also reduces input lag, which is the time between

when the monitor receives the signal from the computer and when it appears on screen. This can be measured in milliseconds and is another one of those stats that once you get below a certain threshold (around 10ms) anyone except e-sports professionals won't tell the difference.

RESOLUTION

4K, 1080p, 1440p – these terms are all screen resolutions, i.e: how many pixels are on the screen at once. The higher the resolution, the crisper the image looks. But pump the resolution too high and your graphics card may struggle to keep up, resulting in slow, laggy graphics. There's a fine

balance between a resolution high enough to look sharp, but low enough to maintain a steady frame rate (FPS) so gameplay is smooth. Gaming at 4K requires a much more powerful graphics card than gaming at 1080p.

The resolution of a display in relation to its screen size can change how large or small on-screen items like icons and text appear. This is called PPI – pixels per inch. A 1440p display on a 27-inch monitor gives what most people would describe as a standard PPI of 108, with text and icons clearly legible at around 60cm away. That same 27-inch monitor, but at a 4K resolution provides a 163 PPI, which results in text most would consider minuscule at standard viewing distances. Games however, can look amazing if they're designed with this in mind – generally called HiDPI support.

RESPONSE TIME

How long it takes for a pixel in an LCD to change colour is called response time. If you're a gamer and the monitor you're using takes too long to change colour, you get ghosting and blurring. A very unpleasant experience.

Response time is often measured in two different ways – BtW (black to white) and GtG (grey to grey). If you check out a monitor's spec sheet and it says "4ms GtG", that means it takes 4ms for the pixels to change from one colour to another, but generally not from black to white. BtW response time is higher as essentially the pixel is going off (black) to on (white), which is slower than simply changing the colour (grey to grey for example).

A good monitor will have a GtG response time of under 10ms. Basically, anything lower than 10ms can't be detected by most normal humans. There are e-Sports pros that demand 1ms monitors, but they're not human.

FREESYNC VS. G-SYNC

When your graphics card is pumping out a different frame rate than that what your monitor's refresh rate is set to, things get weird. Graphics



Monitor size and resolution guide

30-27-inch	27-24-inch	24-21-inch			
			3840 x 2160	4K	
			2560 x 1600	1600p	
			2560 x 1440	1440p	
			1920 x 1200	1200p	
			1920 x 1080	1080p	

response times (1ms), TN panels have you covered.

VA-type panels are relatively new and attempt to take the best bits of TN panels (performance) and IPS panels (colour accuracy) at a lower price than IPS. VA-type panels will have superior contrast than an IPS panel for excellent black levels and have wider colour gamut than most TN panels. However, response times are often not as high as TN units and when viewed off-axis, can actually have worse viewing angles than a TN panel.

For years, IPS panels were the domain of graphic artists and photographers. Their slow refresh rates resulted in gamers choosing lag-free gaming over luscious colours. The latest crop of IPS gaming monitors however are bridging the gap between the TN and VA panels, providing great colour accuracy and high refresh rates (165Hz IPS panels exist now), but you'll pay a hefty premium over a TN or VA panel for it.

HDR

HDR is all the rage right now in monitor land and unlike the 3D fad, HDR (high dynamic range) is emerging as an actually useful thing that games and movies will take great advantage of. For years and years, the sRGB colour gamut was what everyone designed their colour against and assumed everyone had a monitor capable of displaying all the colours in that standard.

When a game is developed with HDR, grass is greener, sunsets are more orange and overall gameplay

start to "tear", with horizontal lines and stuttering as things get out of sync. It can totally ruin your gaming session.

Graphics card manufacturers have come up with different ways of solving this problem. AMD has a thing called FreeSync and Nvidia calls its similar solution G-Sync. At the most basic level, both technologies achieve the same thing – dynamic refresh rate adjustment, but the monitor you buy needs to support the protocol your graphics card spits out.

FreeSync is way more common on gaming monitors as it's part of the DisplayPort 1.2a standard and uses commodity hardware a monitor manufacturer can add to their units at a low cost. Nvidia's G-Sync however, requires the manufacturer to cough up for a chip from Nvidia and that seems to add around \$200 on top of the equivalent monitor with FreeSync.

Regardless of cost, if you're getting a gaming monitor, make sure whatever monitor you buy supports the frame rate adjustment protocol your GPU supports. It's a fantastic feature that works wonders.

TN VS. VA VS. IPS

Practically all monitors on the market fall into one of three LCD panel types. Twisted nematic (TN), vertical alignment (VA) or in-plane switching (IPS). Each one has its benefits and shortcomings when it comes to gaming.

The cheapest monitors tend to be TN-type. Colour accuracy (how close the colours on the screen match up to the reference standards) and viewing angles (what it looks like if you aren't positioned exactly in the middle of the display) are weakest on TN panels. However, if you're after the absolute fastest refresh rate (240Hz) and

RTX 2070 ROUNDUP
FIVE NEW GPUS put to the test

PAX AUSTRALIA 2018
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Worth the WASTELAND wait?

PC PowerPlay

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looks amazing. If your monitor doesn't have the ability to display all the colours a video game or movie made with HDR in mind can show, you're not seeing what the creator of that art intended you to see. That range of colours is called a gamut.

VESA, the monitor standards body, has a certification process that sets minimum HDR standards a monitor must meet to achieve certification. Things like peak brightness, achieving high rates of HDR colour gamuts (i.e: DCI-P3 & BT.709), 10-bit colour depth and various response times and black levels.

If you want to future-proof your monitor purchase and have the cash to spare, nabbing a VESA Certified DisplayHDR 1000 monitor will ensure that as more HDR games and movies are released, your monitor will display all the colours just as they're intended.

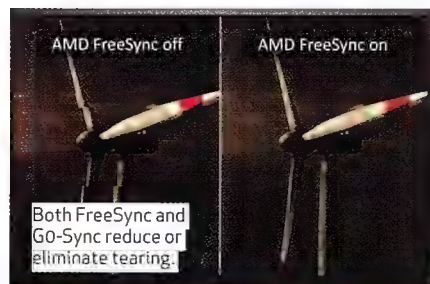


TABLE HEADLINE

NAME	SIZE (DIAGONAL)	RESOLUTION	PANEL TYPE	REFRESH RATE	RESPONSE TIME (GTG)	COLOUR GAMUT	PORTS	PRICE
KOGAN KAMN-49F14UHLA	49-INCH	3840X1080	VA CURVED	144HZ FREESYNC	8MS (4MS OD)	99% SRGB	1X HDMI 2.0, 1X DP 1.4	\$1,199
KOGAN KAMN-341FQULA	34-INCH	3440X1440	VA CURVED	100HZ FREESYNC	16MS (7.8MS OD)	99% SRGB	1X HDMI 2.0, 1X DP 1.4, 1X DVI	\$649
LG 27BK550Y	27-INCH	1920X1080	IPS	60HZ	5MS	99% SRGB	1X HDMI 1.4, 1X DP 1.2, 1X DVI, USB 2.0 HUB	\$399
LG 32GK650F	32-INCH	2560X1440	VA	144HZ FREESYNC	5MS	99% SRGB	2X HDMI 1.4, 1X DP 1.2	\$599
ASUS ROG SWIFT PG27UQ	27-INCH	3840X2160	IPS	144HZ G-SYNC	4MS	97% (DCI-P3), 99% (ADOBE RGB)	1X HDMI 2.0, 1X DP 1.4, USB 3.0 HUB	\$3,499
ACER NITRO VG240Y	24-INCH	1920X1080	IPS	75HZ FREESYNC	1MS	99% SRGB	1X HDMI 1.4, 1X VGA	\$198
PHILIPS 328M6	32-INCH	2560X1440	VA CURVED	144HZ FREESYNC	4MS	120% SRGB	1X HDMI 2.0, 1X HDMI 1.4, 2X DP 1.2	\$599
PHILIPS 436M6	43-INCH	3840X2160	VA	60HZ FREESYNC	4MS	97% DCI-P3	1X HDMI 2.0, 1X DP 1.4, 1X MINIDP 1.4, USB-C	\$999
MSI MPG27CQ	27-INCH	2560X1440	VA CURVED	144HZ FREESYNC	1MS	115% SRGB	2X HDMI 2.0, 1X DP 1.2, USB 3.1 HUB	\$699
BENQ EX3501R	35-INCH	3440X1440	VA CURVED	100HZ FREESYNC	4MS	100% SRGB	2X HDMI 2.0, 1X DP 1.4, USB TYPE-C, USB 3.0 HUB	\$1,099
BENQ XL2720	27-INCH	1920X1080	TN	144HZ FREESYNC	1MS	92% SRGB	2X HDMI, 1X DP 1.2, DVI	\$529
BENQ XL2411P	24-INCH	1920X1080	TN	144HZ FREESYNC	1MS	96% SRGB	1X HDMI 1.4, 1X DP 1.2, DVI	\$329
ACER PREDATOR X34P	34-INCH	3440X1440	IPS CURVED	120HZ G-SYNC	4MS	100% SRGB	1X HDMI 1.4, 1X DP 1.2, USB 3.0 HUB	\$1,299
AOC AG271QG	27-INCH	2560X1440	IPS	165HZ G-SYNC	4MS	100% SRGB	1X HDMI 1.4, 1X DP 1.2, USB 3.0 HUB	\$879



\$1,199 | WWW.KOGAN.COM/AU

Kogan KAMN49F14UHLA

Humongous 49-inch display creates an immersive gaming experience.

This is the largest display in our roundup, at a whopping 49-inches diagonally. Don't be fooled by the large size however, the Kogan unit only has a 3840x1080 resolution – the equivalent of two 1080p displays side-by-side. That resolution on such a wide display results in a low DPI, more like a TV than a computer monitor. When sitting on a desk with the viewer approximately 60cm-70cm away, the image is rather blocky and text fuzzy, particularly for desktop use (web browsing, etc.). When gaming however, the massive curved display creates an immersive experience like no other. Playing a flight sim or motorsports game is a delight thanks to the enveloping 49-inch display.

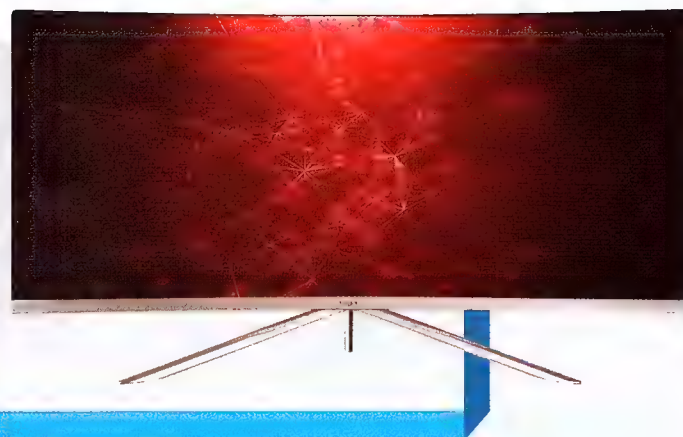
You could get the same resolution as the KAMN49F14UHLA by placing two 1080p monitors side-by-side but the lack of annoying bezels from the middle of the image is

fantastic. Any game you enjoy in dual monitor mode is vastly improved by using a wide display such as this. Keeping the resolution relatively low means mainstream graphics cards won't struggle to pump out 60Hz or above either. Colour gamut (99% sRGB) and response time (4ms) are adequate and what you'd expect from a gaming monitor in 2018.

The bottom line with the Kogan KAMN49F14UHLA is that it's great for replacing dual display gaming setups at a relatively affordable price, but poor for desktop use. Keep this one confined to the gaming rig.

Verdict

Wonderful for certain kinds of gaming, but not useful as a work screen due to the low DPI.



\$649 | WWW.KOGAN.COM/AU

Kogan KAMN341FQULA

A high resolution, curved display for significantly less coin than the rest.

Kogan is known for slapping its name on otherwise expensive tech and selling it in Australia at a low price, which is exactly what the company has done with the KAMN341FQULA. Most 34-inch curved monitors sell for around \$850 to \$1,000, but the KAMN341FQULA is only \$649. For your money you get a rather stylish 3440x1440 1800R curved Samsung VA-type panel that's capable of 100Hz refresh rates and FreeSync support. Kogan don't mention the colour gamut this display is capable of in its spec-sheet, but in normal use it seems to line up with other 99% sRGB panels for adequate colour accuracy.

The lack of a USB hub or multiple HDMI inputs to switch between may bother some people, but there's a reason this monitor is cheaper than the rest of the market, and by omitting features like these – which let's be honest, aren't

exactly the core reason you buy a monitor, let alone a gaming monitor – the price comes down without sacrificing the quality of the display itself. That said, the KAMN341FQULA does have multi-window options like PiP and side-by-side, meaning you can plug in a TV into the HDMI port for example and have it show up on half of the display, with your computer via DisplayPort on the other. Or two computers. Or a console and a computer!

If you've got a GPU that can handle the native 3440x1440 resolution at 100Hz, Kogan's KAMN341FQULA is a no-frills monitor with solid colour accuracy at a bargain price.

Verdict

An excellent all-rounder at a nice price.





\$399 | WWW.LG.COM

LG 27BK550Y

Low refresh rate and average response time make this a poor choice for a gaming monitor.

It's quite difficult to class the LG 27BK550Y as a gaming monitor. For starters, it "only" has a refresh rate of 75Hz despite the 1080p resolution, doesn't seem to support FreeSync or G-Sync, has no particularly gamer-esque features like in-game crosshair overlays or a low response time. The 27BK550Y doesn't even have a cool dragon or tribal symbol on it to denote its gamer worthiness! The only thing that could make this a gaming monitor is the "game" picture setting. That's about it.

The 27BK550Y isn't even that good of a monitor for desktop use, with only a 1080p resolution at 27-inches, text isn't as crisp as it could be like on a WQHD resolution display at the same screen size. Despite being an IPS panel, colour gamut is run of the mill at 99% sRGB. In 2018, a non-gaming, non-budget monitor should be aiming

for DCI-P3 coverage. The 27BK550Y isn't even cheap, selling for around \$400 at most PC stores.

The only upside of the 27BK550Y really, is its stand that can be adjusted for tilt, pivot, swivel and height. It would be excellent if every monitor came with such a flexible stand for correct ergonomics. Other than that, there's not much reason to pay attention to this monitor. It's not awful by any means, but the 27BK550Y has nothing unique about it either, making it very forgettable compared to the other displays we have in this roundup.

Verdict

A lacklustre set of specs relegate this to the boring bin.



\$599 | WWW.LG.COM

LG 32GK650F

High refresh rate, low latency display at an excellent price, with loads of gamer-centric features.

Unlike LG's 27BK550Y, the 32GK650F is way more suited to the needs and desires of the modern video game enthusiast, for not much more money. For starters, it has a high 144Hz refresh rate and FreeSync support, plus a 1ms response time. Those two features combined mean even the most demanding gamer will hardly ever see motion blur or dropped frames.

There's also a few gamer-centric features on the 32GK650F, like "black stabiliser mode" that brightens up dark areas in games with the intention of making it easier to see your enemies hiding in the shadows, and a crosshair overlay that is placed dead in the middle of the display, regardless of what's on it, so you always get the 360 mid-air no-scope headshot.

A resolution of 2560x1440 at 31.5-inches makes for a half decent general use monitor too. Colour gamut is nothing to write home about

at 99%. Unlike some cheaper gaming monitors, the 32GK650F is nice enough to include a blue light filter, to protect your eyes from the unnatural blues most monitors emit.

While the 32GK650F isn't stunning, its ultra-narrow bezel and matte black stand will fit in to any décor. No flashy RGB light setups or room illumination here. Compared to some of the other the top stylings from other brands, LG's restraint here is refreshing.

LG's 32GK650F manages 144Hz refresh rates with FreeSync, 1ms response, QHD resolution and adequate image quality in a tasteful package for only \$599, making it a very solid purchase.

Verdict

A much better effort from LG and very gameworthy.





\$3,499 | WWW.ASUS.COM

Asus ROG Swift PG27U

One of the best monitors ever to grace our test bench, but a high price.

Out of the 14 monitors getting reviewed here, the Asus ROG Swift PG27UQ is the best one, by far. Just look at these specs: 4K, 144Hz, DCI-P3, HDR and G-Sync – fantastic stuff that's as good in person as it is on paper. Unfortunately, the \$3,499 asking price for the PG27UQ is more than double the price of the second most expensive monitor in this review.

Forgetting price for a minute, the PG27UQ is an excellent display. With other monitors you need to decide between high refresh rates or high-quality colour. With the PG27UQ, you get both! A resolution of 3840x2160 on a 27-inch screen results in a 163 PPI that makes game graphics razor sharp. The DCI-P3 colour gamut and HDR support (HDR10 & DisplayHDR 1000) mean not only are those graphics sharp as a tack, the colours are deep and rich – all at 144Hz. The only thing you

could take a shot at with the PG27UQ is the "low" 4ms response rate and no support for AMD's FreeSync, only Nvidia G-Sync.

It would be poor form not to mention the bizarre "ROG Light Signal" that projects a ROG logo onto a wall to "show your gaming spirit and create the perfect atmosphere for your gaming setup". What a bizarre feature.

If you've got a rig powerful enough to pump out 4K at 144Hz and have cash to spare, buy the Asus ROG Swift PG27UQ – you absolutely won't regret it (until your credit card statement arrives).

Verdict

Without doubt the greatest gaming monitor ever made, with every cutting edge feature included.



\$198 | WWW.ACER.COM

Acer VG240Y

This budget IPS monitor claims 1ms response time, but in the real world isn't all its cracked up to be.

24-inch monitors aren't as glorious as the 49-inch or 34-inch monsters on the market these days, but for the gamer on a budget who just wants to enjoy some fast paced 1080p gaming, they can still provide a robust gaming experience. Acer's VG240Y is just the type of monitor for that type of gamer.

For a relatively cheap gaming monitor, it's interesting Acer went with an IPS panel in the VG240Y. This is partly why the refresh rate tops out at 75Hz, which isn't awful, but the main benefit of 1080p gaming is the high frames per second you can achieve, but this monitor won't be of any use if your FPS goes above 75.

Acer claims the VG240Y has a 1ms response time, despite its IPS panel, using what Acer calls "Visual Response Boost" technology. Turn this on in the settings and response times improve, but strobing becomes more

apparent. Without VRB, response times are around 10ms, nothing special. Unfortunately, image quality is very average in desktop use, with poor colour gamut and a weird mesh look on the display that's quite visible on solid bright colours.

For those who just want a simple 1080p 60fps gaming experience on a decent looking monitor on a budget, you probably want to look elsewhere. The Acer VG240Y may be an IPS panel, but image quality isn't much better than a VA or even a TN panel and lacks the advantages (high contrast or high refresh rates) those panel types provide.

Verdict

An odd mix of very quick response time and relatively slow refresh rate.





\$599 | WWW.PHILIPS.COM.AU

Philips 328M6

Amazing value for money display with high refresh rate, ideal PPI and above average colour gamut at a great price.

Philips has been releasing some excellent value for money displays lately and its 328M6 looks like it continues that trend, providing a 32-inch, 1440p, 1800R curved VA-type panel, with 144Hz refresh rate, 4ms response time, 3000:1 contrast ratio and 120% sRGB coverage for \$599.

Image quality at 144Hz is solid, response times of 7ms are low for a VA panel and input lag is minimal. Out of the box, colours are well calibrated and unlike many other gaming monitors, are suitable for basic photo editing, making the 328M6 a great display for those using their computers for more than just gaming.

The 328M6 has a neat party trick Philips called Ambiglow, which is a strip of LEDs on the bottom the case that light up in unison with what's being displayed on screen. It's supposed to create a more

immersive experience, but that's highly debatable.

Built-in speakers are generally trash, but the 328M6's are pretty good considering there's no subwoofer. The stand could do with an upgrade, as the only adjustment available is forward and back tilt, plus it feels a little flimsy for a screen this big. Anyone wanting to hook up a TV tuner, a gaming console or a second PC to their display will appreciate the 2x DP and 2x HDMI ports.

Of all the monitors in this review, the Philips 328M6 is the gaming best bang for buck. For only \$599 you get a display with all the latest features and no show stoppers.

Verdict

Easily the best value pick of the group that doesn't leave you wanting more features.



\$999 | WWW.PHILIPS.COM.AU

Philips 436M6

More of a TV than a monitor, but HDR certification makes this a perfect display for movies as well as gaming.

The Philips 436M6 is a TV masquerading as a computer monitor. At 43-inches diagonal, it's more suited to people's living rooms than their desks. Unlike most TVs however, the 436M6 is the first monitor to receive VESA DisplayHDR 1000 certification, which considering the \$1,000 price point and 4K resolution, makes for a very interesting display.

One of the benefits of having a 4K resolution on such a large screen is the lack of window scaling or zooming, so Windows won't have a fit when using an app incompatible with window scaling. The downside however, is the loss of pixel density, resulting in a lack of clarity and detail, particularly with text, that you get at 4K resolution on a smaller monitor (i.e: 34-inch or 40-inch). You'll need to sit a bit further away than usual with the 436M6, around 80cm to

90cm is the sweet spot so the 43-inch screen fills your peripheral vision.

For gamers into fast frame rates, the Philips 436M6 will disappoint as it's not capable of much beyond 60Hz, despite supporting AMD FreeSync. But those seeking image quality rather than twitch gaming will be delighted with the DCI-P3 colour gamut and great HDR support will make games that support it look fantastic. Which this price point, on such a large display, is an excellent achievement. Just make sure your graphics card can do 4K at 60fps to get the best out of the Philips 436M6.

Verdict

Incredible value considering the sheer size. Perfect for lounge room gaming.





\$699 | WWW.MSI.COM

MSI MPG27CQ

A competent gaming monitor with plenty of LED bling to compliment your tricked-out gaming rig.

A 27-inch display makes for the ideal single monitor experience. Big enough to fill most of your vision, but not so big that you're removing your noggin all over the place to see what's going on. It's curious then, why MSI decided to give the Optix MPG27CQ a subtle 1800R curve. Besides this probably marketing induced oddity, the Optix MPG27CQ is a solid gaming monitor.

144Hz refresh rate with FreeSync support and low response time (~9ms full black to white) will keep the twitch gamers happy. 2560x1440 will be useful for web browsing and other stuff when not gaming. 82% DCI-P3 colour gamut means it's better than most panels in this price range for satisfying colours. Even those into a bit of bling will like the inclusion of RGB LEDs on the base of the Optix MPG27CQ that can be controlled via Steelseries' GameSense software. Being a VA-type panel,

contrast is great, but viewing angle suffer compared to an IPS. At 27-inches with a slight curve, making sure you're smack bang in the middle of the display shouldn't be an issue. Backlighting on the Optix MPG27CQ is very even, with no obvious bleeding either.

Despite the Optix MPG27CQ panel being of high quality, calibration was difficult due to the limited OSD options. Luckily out of the box the Optix MPG27CQ is fine, but it could be so much better if MSI provided more flexibility to tweak colour settings.

Verdict

A very good monitor from new entrant in the game.



\$1,099 | WWW.BENQ.COM

Benq EX3510IR

Great attempt by Benq to create a perfect all-round monitor, but shortcomings spoil the show.

On paper, the Benq EX3510IR seems to tick all the boxes. 35-inches with an 1800R curve and 3440x1440 resolution make for a perfect combination of screen size and pixel density. 100Hz refresh rate with FreeSync support, whilst not the 144Hz gold standard, is more than enough for most people, particularly at this resolution. The EX3510IR even supports HDR10 for richer colour in supported applications.

Design wise, the EX3510IR is sleek, without the usual adornments a "gaming" monitor brings – but don't let that fool you, as with FreeSync and 100Hz refresh rate support, this monitor has some proper gaming cred. Full black to white transition is very low for a large curved ultrawide display, at only 11ms. Anyone except the most demanding of gamers will be pleased.

As the EX3510IR is a modern display, it supports

connecting your computer to it over USB-C, but if you connect a laptop, it will only supply 10W of power. Would it have killed Benq to include a slightly larger power supply to make this feature immensely more useful?

The EX3510IR's support for HDR10 leaves a lot to be desired as the colour gamut it supports isn't realistically a proper HDR format, achieving only full sRGB coverage (which it does excellently, out of the box), not DCI-P3 or even close to Rec.2020. That doesn't mean this display is poor, far from it, but if you're buying it with the intention for HDR fun times, there's better, albeit more expensive, monitors out there.

Verdict

Almost there from Benq, and still great if HDR or USB power aren't important to you.





\$529 | WWW.BENQ.COM

Benq XL2720

At launch this was fantastic, but has since been outclassed by cheaper, younger competition.

The Benq XL2720 is a bit long in the tooth now, having come onto the market back in 2014 packing an, at the time, whopping 144Hz refresh rate at 1080p on a 27-inch TN panel. When the XL2720 hit the market, not only were its specs impressive, but it debuted relatively unique features like Blur Reduction, input lag compensation and more.

One very unique feature is the S Switch. Instead of fiddling around the rear of the monitor with buttons or a d-pad to adjust settings, Benq's S Switch is like a mini keyboard that attaches magnetically to the base, where you can use a scroll wheel and preset buttons to make rapid adjustments via the OSD.

Being a TN panel, contrast will never be as good as VA panel, but the XL2720 puts up a good fight, demonstrating strong black levels. Unfortunately, being a TN panel, colour gamut is average, reaching 95% sRGB

coverage after calibration. The other weakness of a TN panel are viewing angles. On a 27-inch display, this becomes apparently with even slight off-centre viewing.

In 2018, you can get the same 27-inch display as the XL2720, but with 1440p resolution and an IPS panel with higher colour gamut, whilst retaining the precious 144Hz refresh rate. This fact makes it difficult to recommend. There are nice gamer-centric tweaks like the S Switch, but considering the relatively high price (\$529) and poor colour gamut, there's newer options on the market now you should buy instead.

Verdict

If you can find one considerably less than the price shown here it's worthy of consideration.



\$329 | WWW.BENQ.COM

Benq XL2411P

If you've got an e-sports gamer on a budget, this monitor will fit the bill.

Benq's Zowie XL2411P claims to be the "premiere e-Sports monitor", which is probably stretching things, but it definitely is well suited for those damaging their posture and wrists in the name of e-Sport glory on a budget. At only 24-inches wide, this smaller size allows Benq to pack in the gaming features people want, at a price they can afford.

The headline feature is 144Hz support at a 1080p resolution. This is the sweet spot for gamers without 6 figure setups, who prize smooth frame rates over high resolutions. At 1080p, 144fps comes way easier than at 4K. To make the most of those 144 frames per second, a blur reduction feature can be enabled to strobe the backlight and reduce perceived motion blur and ghosting. The downside of that however, is reduced brightness. But played a typically dark room, it's not an issue at all.

The XL2411P Black eQualizer's feature won't solve racial relations any time soon, but it will let you see any video game enemies hiding in the shadows. When enabled, the monitor will decrease contrast on darker parts of images dynamically. It works quite well, with low false positive and can come in pretty handy.

At \$329, the Benq Zowie XL2411P is one of the cheapest 144Hz, low latency monitors on the market. If you're an e-sports gamer, where refresh rate and low latency matters above all else, but don't have budget for a bigger monitor, add the Benq Zowie XL2411P to your shopping list.

Verdict

Purpose built for supreme e-Sports gaming, but less appealing if you just want glorious eye candy.



apc
HOT PRODUCT

\$1,299 | WWW.ACER.COM

Acer Predator X34P

An excellent combination of image quality, game performance and desktop use make it pick of the bunch.

The Acer Predator X34P is the follow-up to Acer's much lauded Predator X34. This new model retains the 3440x1440 resolution and G-Sync capability but adds a 120Hz refresh rate and a more aggressive 1900R curved panel.

Endowed with an IPS panel, you can be off-centre with the X34P and still enjoy excellent colours and brightness. The X34P is also a very even display, with no bright spots or backlight bleeding. 100% sRGB colour gamut however, is a bit old school. It would be nice to have an IPS panel achieve 120Hz refresh rates and support DCI-P3. That said, there aren't exactly loads of HDR-compatible gaming titles on the market now, so we aren't missing much. The target audience for the X34P will appreciate the 120Hz refresh rate at 3440x1440 more than HDR at the moment.

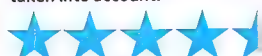
Out of the box, the X34P requires some tweaking in the colour department, but

once calibrated, is about as good as you could hope for with a 120Hz panel and is superior to most VA and every TN panel. Input lag is not noticeable and black to white response times of 9ms on the X34P are superior to many VA panels.

Of all the monitors in this review, the Predator X34P is the best overall package. The 1900R curve fits all 34-inches of display your peripheral vision nicely, 120Hz with G-Sync support is plenty most gamers, 3440x1440 is an incredibly useable resolution without the need for image scaling and the colour quality, whilst not the best, is above average.

Verdict

A stunner in every respect and our top pick in this test when value is taken into account.



✓✓✓
apc
RECOMMENDS

\$879 | AU.AOC.COM

AOC AG271QG

Fantastic value for money IPS display that pumps out 165Hz while retaining image quality.

27-inches wide, 1440p resolution, IPS panel, 165Hz refresh rate and Nvidia G-Sync support for \$900? No that's not a typo. With those specs and pricing, the AOC AG271QG makes a very compelling argument for the Nvidia gamer looking for cutting edge display tech without breaking the bank.

Being an AHVA IPS panel, colour uniformity and viewing angles are excellent. It's fantastic AOC has packed an IPS panel into the AG271QG and still made it pump out 165Hz. By default, the AG271QG operates at a maximum of 144Hz. If you want 165Hz goodness, go into the monitor's OSD and turn on ULMB (ultra-low motion blur). Be warned though, enabling ULMB has the side-effect of disabling G-Sync, so unless you're confident your rig can pump out 165fps consistently, you probably want to leave ULMB turned off and run the AG271QG at 144Hz. The perceivable difference

between 144Hz and 165Hz is minor anyways.

Out of the box, colours are serviceable, but once calibrated, you can achieve close to 100% sRGB. Sure, it's not the 99% DCI-P3 other monitors spoil you with, but at this price point and with a 165Hz refresh rate, 99% sRGB is nothing to sneeze at and for gamers, well worth the compromise.

If 240Hz refresh rates and 1ms response times are that matters for you, grab a TN panel and put up with the reduced image quality. But if you plan on using your monitor for more than gaming, the AOC AG271QG's mainstream size, resolution and image quality make it a perfect all-rounder at an affordable price.

Verdict

A fantastic choice that ticks every box and comes in at a very competitive price.



BACK TO BASICS BUILD GUIDE

An in-depth step-by-step budget build guide.
Zac Storey

For the experienced, building a PC is an easy, often therapeutic experience. Each part fits into its designated slot, each cable is carefully woven around the frame, and each power-on is successful. However, for a vast swathe of folk, it's nothing of the sort. PC building can be a daunting task, especially if it's your first time. After all, you're messing around with delicate parts that can cost upward of half a month's paycheck. One little slip, one jolt of static, one cable in the wrong place, and boom – you're out of pocket and out of luck.

So, why bother? You can pick up a pre-built PC for a similar amount of cash as building your own – and let someone else worry about everything. It's convenient, easy, and saves a whole ton of time. Combine all that with numerous tech sources and journalistic outlets (ourselves included) focusing on the very extreme end of computing, and finding the info you need to take you through the process of building a system right from the start is challenging.

However, the fact is that, more than anything, building your own system is actually a relatively easy and satisfying experience. It's about taking the exact hardware you want, and combining it all into something that suits you perfectly. By building your own rig, you know exactly what goes in it, where potential problems can arise, and what you can do to improve it. On top of that, it's yours. You built that, nobody else, not another company – you did it.

This time around, we decided to pull out a bit of a double whammy. Firstly, we're talking a sub-\$1,000 hardware budget, and an attempt to build a fairly respectable 1080p gaming machine, with all the gizmos you need, including 620GB of storage, an SSD, 8GB of DDR4, and a fairly meaty processor. Or, at least, enough to get by just fine with the latest titles. We're combining that with a super-granular, in-depth guide to take you from the very beginning to the very end of your own budget build.

INGREDIENTS		
PART		PRICE
CASE	COOLER MASTER MASTERBOX LITE 3.1	\$65
MOTHERBOARD	GIGABYTE B360M D3H	\$109
CPU	INTEL PENTIUM GOLD G5600	\$105
MEMORY	8GB (2X 4GB) CRUCIAL BALLISTIX SPORT LT @ 2,400MHZ	\$149
GPU	GIGABYTE GEFORCE GTX 1050 2GB OC	\$199
PSU	EVGA 430 80+ BRONZE	\$69
OS DRIVE	120GB KINGSTON A400 2.5-INCH SSD	\$35
DATA DRIVE	1TB WESTERN DIGITAL BLUE 3.5-INCH HDD	\$59
COOLING	STOCK	\$0
OPERATING SYSTEM	WINDOWS 10 64-BIT	\$145
TOTAL		\$935





Kingston



PRICES WERE CORRECT AT TIME OF PRINTING

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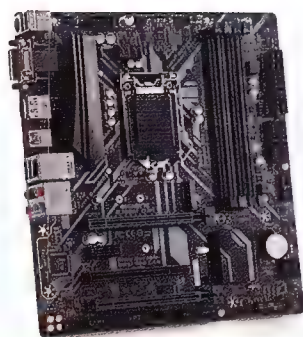
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Intel Pentium Gold G5600 \$65

This little beauty, coming in at \$65, packs two full-fat cores, plus Hyper-Threading, to give us a total of four threads, all clocking in at a base frequency of 3.9GHz. That's not exactly a small figure there. Ultimately, all of those stats come together to give us a fairly fast Coffee Lake processor that's more than capable of driving the latest games with ease. It also comes with a cooler as standard, so win-win.



Gigabyte B360M D3H microATX \$109

With a good processor, you need a good motherboard. We've sprung a little extra cash into this purchase, but in the long run, it's very much worth it. Gigabyte's B360M D3H is a microATX fun house of future connectivity. You've got multiple SATA ports, support for onboard USB 3.0 and 2.0, four PWM fan headers, support for all of the Coffee Lake series of processors (from our lowly Pentium all the way up to the Intel Core i7-8086K), and, more importantly for us, support for an M.2 PCIe SSD.



8GB (2x 4GB) Crucial Ballistix Sport LT @ 2,400MHz \$149

8GB is plenty for all your gaming needs, especially at 1080p. It's likely that within the next four years, you may need to double that capacity, but only for the highest of high-end titles. Fortunately, the Gigabyte B360 motherboard supports four sticks of DDR4, so it would simply be a case of buying a second set of the Crucial Ballistix Sport LT featured above and adding it to what you already have.



Gigabyte GeForce GTX 1050 2GB OC \$199

The 1050 is a somewhat slower card than its bigger brother, but it still packs just enough punch to tackle most 1080p titles. Though, you can't just throw everything to Ultra and leave it there if you want an acceptable frame rate. Most mainstream esports titles, *Overwatch*, MMOs, MOBAs, and the like will play well into the 100fps mark, but for any other graphically intensive title, you should drop the quality of the textures and lower antialiasing where you can to reduce the overall load on the GPU.



120GB Kingston A400 2.5-inch SSD \$35

What would any modern system be without a solid, quick, and dependable hard drive behind its OS? Nothing, that's what. Sure, those old spinning platters may be far cheaper than their flash-based rivals, but nothing compares to having the instantaneous response of an SSD. It's one of the biggest leaps you can make as a PC enthusiast, swapping from a hard drive to an SSD, and we certainly wouldn't build a system nowadays without one. Whether it's 2.5-inch or M.2, there's an SSD for everyone, at any budget.



1TB Western Digital blue 3.5-inch HDD \$59

If you're on a budget, and don't mind being a little more scrupulous with your games and content, running with a 1TB HDD for your backup drive isn't too much of a stretch.

Western Digital is one of the better hard drive brands out there. And the Blue series is primarily intended for reliable desktop use, so this \$59 box of joy will serve you well. The WD Blue series also supports SATA 6.0 Gb/s, and together with a relatively decent 7200 RPM rotational speed will deliver performance that will keep access times reasonable.



430W EVGA 80+ Bronze ATX \$69

EVGA's BT450 is by far our favorite budget power supply. It packs plenty of juice for any modern-day system (twice as much as what is needed here under load), and also comes with an impressive three-year warranty. Of course, it's not the most efficient of power supplies, it's non-modular, and that warranty isn't as good as the 10-year titans EVGA also sells, but for the price, it's arguably one of the best choices you can make.



Cooler Master MasterBox Lite 3.1 microATX \$65

Cooler Master's MasterBox has been a solid favorite of ours for a while, and this microATX offering is no different. Although stripped down in comparison to some of the other MasterBoxes, the 3.1 still keeps some of the basic design elements, alongside a few nifty cost-cutting measures. There's not a huge amount of room for cable management, but the size of the rear side panel has been increased to compensate for your cable bulge. It still features a full-fledged front I/O.



The budget-busting 1080p build

With just \$1,000, is it possible to build a PC capable of gaming on today's 1080p planet? Let's find out...

Back to basics—how on earth did we come up with this one? Well, as graphics card prices have fallen, and the cost of memory is more reasonable than it has been of late, we thought it was time to see what you could do with an absolutely minimal budget. You'll notice we keep referring to a "hardware budget" in particular – that's because the operating system cost is one of the biggest variables.

In reality, this system is designed with Windows 10 in mind. You could game on Linux for free (or by paying a donation of your choosing), and we've covered that before – unfortunately, though, for now, Microsoft very much holds the keys to the kingdom. If you have a license already, it

makes this build ridiculously affordable. Those not so lucky have two options: Either you can chunk out for a full license, bound to an email address, which will set you back around \$100 or so; or you can see whether you can buy yourself an OEM one-time Windows 10 code online. These are typically available from less reputable sellers, and usually, if you can purchase a legitimate key, you'll find that it's a one-hit wonder. Pop that motherboard out, and whammo – you'll need a new key. We always recommend you pick up a legitimate Windows license from Microsoft, and anchor it to an email account. If you do, activating any new machine is a piece of pie. Simply log in with your Microsoft account, and you're good to go.

PRICE VERSUS PERFORMANCE

So, where do you begin with a build like this? Well, for us it all started with the processor. Knowing Coffee Lake to be the beast it is – and in a lot of ways, we have AMD to thank for this – means that we know those single cores can hammer out some seriously strong IPC. What that translates to is plentiful frame rates in game, and a smooth desktop outside of it. Thanks to the Coffee Lake core count bump, the Pentiums of today easily match the Core i3s of 2016 and earlier. In the process, they've become an ideal part for some low-end gaming.

Now, you could technically do something similar with an AMD build, but you'd be laying down a lot more cash in the process. Yep, we never thought we'd say this, but Intel's budget offerings are actually pretty incredible right now, and AMD currently can't match them on price.

Next on the list was the notion that prior to working for this magazine, this journo was only using a GTX 660 2GB to game on back in 2015. All in all, it was a pretty comfortable experience, especially at 1080p. Games have come a fair way since then, but the reality is that game developers always cater to the largest portion of the community, meaning they need their title to look awesome on the high-end settings, but be accessible at the mid-range, too. The GTX 1050 2GB is the perfect fit, then. It's the successor to the GTX 950, which, in turn, supplanted the GTX 760 and the GTX 670. So it must, by default, be a capable gaming GPU.

Combine that with 8GB of DDR4 and a decent-sized SSD for your OS install, and you're suddenly looking at

PARTS LIST

PART		STREET PRICE
CASE	COOLER MASTER MASTERBOX LITE 3.1	\$65
MOTHERBOARD	GIGABYTE B360M D3H	\$109
CPU	INTEL PENTIUM GOLD G5600	\$105
MEMORY	8GB (2X 4GB) CRUCIAL BALLISTIX SPORT LT @ 2,400MHZ	\$149
GPU	GIGABYTE GEFORCE GTX 1050 2GB OC	\$199
PSU	EVGA 430W 80+ BRONZE	\$69
OS DRIVE	120GB KINGSTON A400 2.5-INCH SSD	\$35
DATA DRIVE	1TB WESTERN DIGITAL BLUE 3.5-INCH HDD	\$59
COOLING	STOCK	\$0
OPERATING SYSTEM	WINDOWS 10 64-BIT	\$140
TOTAL		\$935

a very appealing platform for anyone who's looking at getting into PC gaming or building their kid a system to go back to school with, or simply someone who wants a good all-around machine.



1 PRE-BUILD PREP

So, the hardware's turned up, you've got a solid work area to build your rig in, and you're good to go. What's first? Well, after taking your woolly socks off and touching something metal to get that zappy goodness out of your fingertips, you're going to want to unbox your chassis. This is where you'll encounter a few issues. Firstly, with polystyrene and a plastic bag sliding out of a cardboard box it means that every case will almost always zap you with static electricity. So, de-charge yourself again immediately after you remove the case, polystyrene, and plastic bag from the box. Then place both the polystyrene packaging and bag back in the box for later.

2 CHASSIS STRIPDOWN

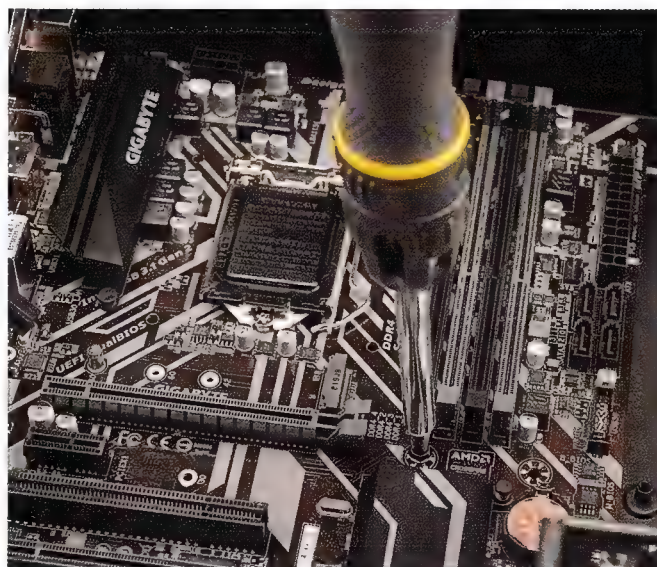
Next you'll want to empty out the chassis as best you can. There's almost always some form of accessory bag included, with the relevant screws, cable ties, and other helpful things (in this case, a box with the black and white accents). Remove as many panels as you can, either by removing the thumbscrews, or by popping the plastic pegs out. Then place the panels back into the cardboard box for later. It's also worth getting a bowl of some description, in which to place the screws you'll be using, because it stops them from rolling around all over the place. Some of the thumbscrews can be overtightened from the factory, so it might be helpful to use a screwdriver to give you a little extra leverage on the tricky ones. Also, leave the front I/O cables tucked somewhere inside the case for later.





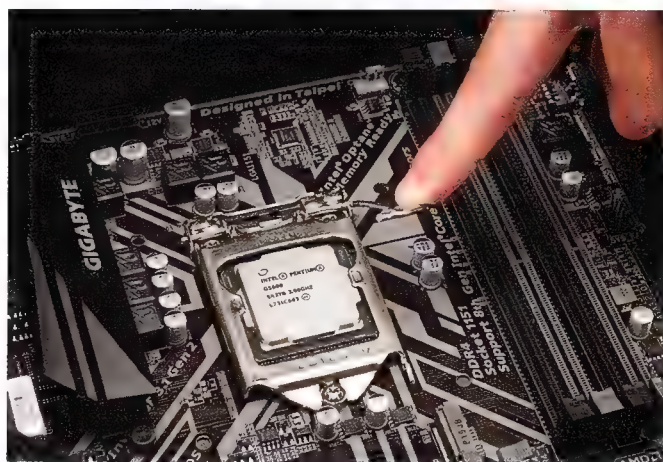
3 MOTHERBOARD I/O

The number of times we've forgotten this little plate. Now you've got everything out the way, you can install the backbone of your system: the motherboard. First, open the box and find the rear I/O plate, located below the board with the accessories. It's a rectangle that goes in the back of the case to protect your I/O from damage. Look at your motherboard, see which side the holes need to be for each portion of I/O (audio is almost always closest to the GPU slots), then push the I/O bracket into place, from the inside of the chassis. It should click into place quite easily.



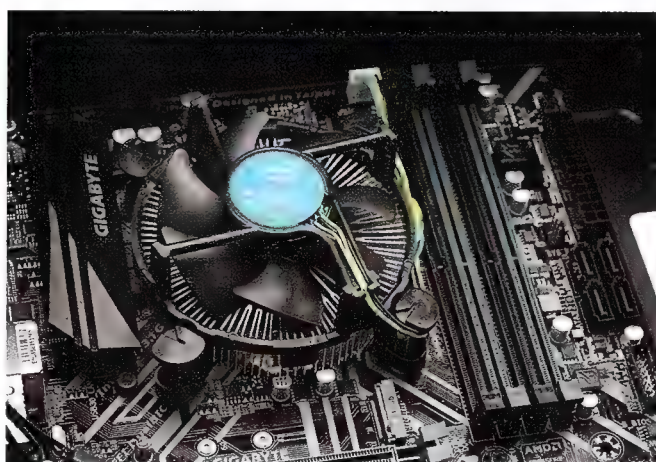
4 STAND-OFFS & SCREWS

Depending on your chassis, you might need to install the stand-offs yourself. These are tiny screws with a thread on the top that give your motherboard a raised platform to stand on. In our case, Cooler Master includes these inside the screw bag, with a neat Phillips head stand-off screw installer. Look at the chassis, and note the "M" on the pre-drilled threads in the case. This is where you need to install the stand-offs for your microATX motherboard. Check where the stand-offs are going against the screw holes on your motherboard. You may find some aren't on the motherboard, or the motherboard doesn't cover all the stand-offs – this is fine. Once you've got the stand-offs in, place the motherboard on top of them, wedge it up against the rear I/O plate, and screw it into place.



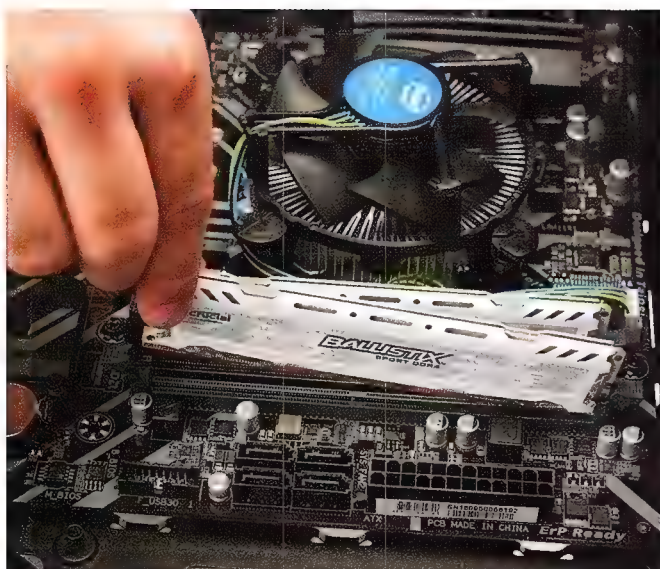
5 PROCESSOR INSTALLATION

Now your motherboard is securely in place, it's time to install the big bad. And by that, we mean the processor. It's a scary business installing Intel processors, not least because if you bend one of those pins in the socket, it'll mean a quick RMA, and a halt on your build. For an Intel system, you're going to want to note the location of the triangle etched in the bottom-left corner of the silver CPU bracket. Push down and lift up the retention arm you can see us holding here. Then, noting the golden triangle on the corner of your CPU, gently place it into the socket. No wiggling, no forcing, just so the triangles are in alignment, and everything fits comfortably. You can leave the black plastic cover in place. Carefully secure the bracket back down under the screw, then push the retention arm back down and under to secure the CPU. The black plastic cover will pop off. If it doesn't, gently pull it.



6 THERMAL COOLING

Processors get hot, which means you need to cool them. We're using the stock fan Intel provides with its non-unlocked processors. It's more than enough to keep our build happy. Usually, we'd apply a small dot (half a pea size) of thermal paste in the middle of the processor before attaching a cooler of some description. However, in this build, the stock Intel cooler has thermal paste pre-applied to the bottom. Simply remove the plastic cover on the heatsink, line up the four pegs on each corner of the fan with the holes in the motherboard surrounding the CPU socket, and push them into place. Once there, rotate the pegs counterclockwise to lock it in place. Then run the CPU fan cable to a PWM fan header on the motherboard. These look like four pins, and are usually labeled. We recommend you install this into the CPU one. There's a notch on the cable to stop you plugging it in the wrong way, and you may need to remove the cable from the clips holding it on to the CPU fan to reach around the other way, as we have here.



7 MEMORY MATTERS

Now you've got your CPU fan installed and plugged in, it's time to install the memory. You should have bought a dual-channel kit for your build. To install this, notice the notch on the bottom of each stick, where the connectors are. You need to line these up with the notches in the memory slots. Lift up the latches on both sides of each memory slot, then lining up the memory stick, carefully slot it into place, until both latches on either side click down securely. Additionally, unless you're installing four sticks, make sure you use the color co-ordinated memory slots, to enable dual-channel memory speeds. Under no circumstances should you be using a single slot of memory for your build, because this limits overall memory bandwidth by half, regardless of how much memory it gives you.



9 POWER SUPPLY INSTALLATION

When it comes to installing the power supply, you have two choices: fan down, or fan up. In a liquid-cooled build or one with an AIO, we recommend you install it with the fan facing down. If any water leaks from the cooling block, there's minimal chance that gravity will drag it into the fan and fry the system. With the fan up, it draws warm air down and out of the chassis. It also affects how much play you have in the cables when you're installing them. Once the PSU is in place, simply use thumbscrews to secure three or four of the threads through the back of the chassis, then run the cables out through the back of the case, next to the motherboard.



8 HARD DRIVES FOR DAYS

In our build, we have both a 2.5-inch SSD and a 3.5-inch HDD. The SSD is for our operating system, because it has limited storage, but is incredibly fast, and the 1TB HDD is for everything else. To install the 3.5-inch hard drive, slide it into the caddy, as pictured here, with the ports facing out toward the back of the case. Then, simply use one of the included thumbscrews to secure it in place. The SSD slots into the top, and is secured by two small screws at the front. We decided to angle the ports, so they were facing the motherboard, to make it a little easier to run the cables later. You can also install the SATA data transfer cables now. You'll find these in your motherboard box; they have L-shaped connectors. Connect one to each hard drive, then run it through the back of the case, and into one of the L-shaped ports on the motherboard.



10 FRONT PANEL FUN

So, you've got the PSU installed, and all the cables out of the back, so now it's time to plug in all the front panel connectors. Usually on the bottom-right of the motherboard, you'll find a selection of pin-outs to which you can attach the connectors. Your motherboard manual will tell you which connector needs to go where, but usually on the mid-range options and above, those details are actually written on the motherboard itself as well. With the MasterBox, the front panel connectors come bunched up on a group of wires, all attached together – you can pull these apart and separate them slightly to give you some leverage to plug them into the correct position. It's also a good time to plug the audio pass-through (located bottom-left), the USB 2.0 header (check the pin slots on each plug, so you don't get confused with the audio pass-through), and the USB 3.0 header into the motherboard.



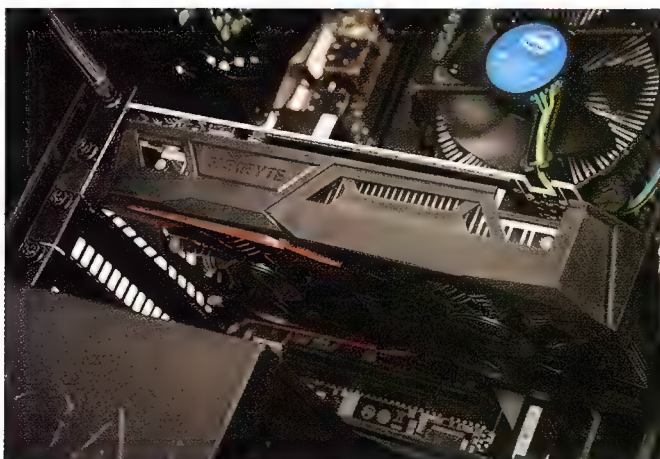
11 ATX POWER INSTALLATION

Now the PSU is in, the front panel cables are all connected, and your USBs are firing, it's time to add some power to your system's main hardware. First up on the list is the 24-pin ATX power. You'll recognize this cable simply by its sheer size. Most power supplies come with a 24-pin that splits up into two segments: a 20-pin and a 4-pin. This is to support older motherboards that don't require the full 24-pin power. However, our system very much does. Simply clip the additional 4-pin power into place on to the side of the 20-pin cable, note the latch on the cable, line it up with the notch on the motherboard, and push it into place. Job done – first cable all sorted.



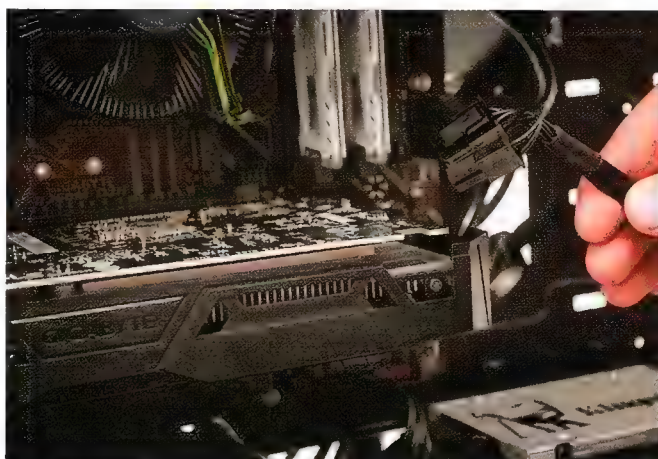
12 CPU POWER INSTALLATION

Your motherboard's got juice, so let's sort out the CPU. Your EPS power cable looks like a PCIe power cable, although it usually has EPS or CPU written on the plug. Its pins are also different shapes, so there's no way you can plug a PCIe power connector into a CPU connector. On a bigger chassis with better cable management, you'd run it up the back of the motherboard and into the eight-pin socket. In our case, there are no cut-outs to do that. There's also not enough cable to run it from the side. We could run it straight up from the power supply, but that's messy. Instead, we'll unscrew some of the screws holding the mobo in place, near the socket, then thread the CPU power through the CPU socket cut-out on the mobo tray, then up into the power supply slot, letting the mobo stand-offs act as cable management space, before securing the motherboard back down.



13 GRAPHICS CARD TIME

Now you're all powered up, it's time to fit your GPU. To do this, you'll first want to remove two of the PCIe covers located at the back of your rig. Find the two that are closest to the topmost PCIe slot. Use a screwdriver to remove them, and set them to one side. Then, take your GPU and carefully slot it into place, with the rear I/O pointing out toward the back of the case, from where you removed those PCIe covers earlier. Once that's done, push it into place until it clicks into the slot. Finally, secure it down with the two screws you removed from the PCIe bracket covers earlier, and that's all there is to it.



14 GPU POWER

Some graphics cards need additional power, because although they draw power directly from the PCIe slot they're placed into, the higher-end cards demand more juice to run correctly. Don't worry if you forget, and you power on the system without it, because you'll receive a message on boot telling you to power down the machine and plug in the additional cables. PCIe power cables are usually labeled, and come as a daisy-chained plug. In our build, however, our card doesn't need any additional power. So, for us, it's simply a matter of tying the cables up, and putting them somewhere out of the way in the bottom of the chassis. Once this is done, you simply reattach all the panels you removed in step one, which are safely stored in your chassis box, and you're good to go.

Set Up Your Software

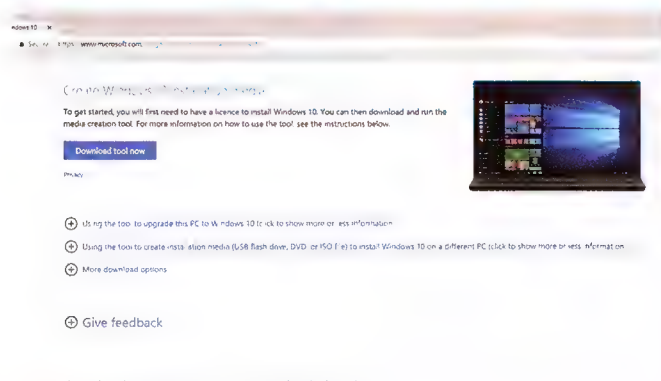
From BIOS to boot, follow our guide to installing your operating system, device drivers, and a selection of essential apps, one simple step at a time.

You've made it. You've got a brand new rig, and you're ready to start winning and enjoying the sights in those 1080p games. But how do you get there? How do you install an operating system on your new machine? You haven't installed an optical disc drive in your chassis, and you don't seem to have one laying around either, so where do you go from here? No need to worry – we've got your back. The last time we used one of those DVD readers was way back in 2016, and even then that was only to see whether the coverdisc of our friends over on *PC PowerPlay* would read properly. Spoiler: It did, then they trashed our DVD drive. Typical, right?

But enough waffle. You're here to install your OS of choice. For us, that's Windows 10. You could game on Linux, if you want, but because this is *APC*, not *Game Releases Two Years Later PC*, unfortunately (or fortunately, depending on your point of view), we're stuck with Microsoft.



"How do you install an operating system on your new machine? You haven't installed an optical disc drive in your chassis, and you don't seem to have one laying around either."



1 BOOTABLE MEDIA STICK

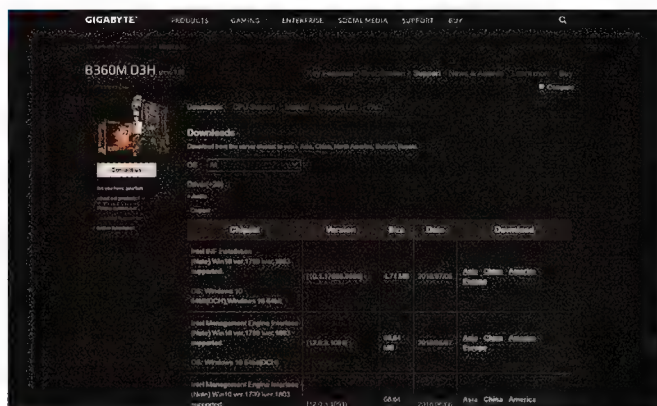
First thing you need to do is grab an 8GB USB stick, preferably 3.0, if you've got one. But, as this is mostly a one-time deal, it doesn't hugely matter. Then, on another system, with Windows already installed, you need to go to <http://bit.ly/Win10MediaKit> and hit the "Download tool now" button. This gives you an EXE file that you can then use to download and create a bootable USB stick. On MacOS or any Linux distro, you're given an ISO instead of this, so you have to use a third-party program, such as Etcher, to mount the ISO on the USB stick.

2 FIRST-TIME BOOT & BIOS

Now you've got a bootable OS USB stick, you need to plug it into your new machine, add a keyboard and mouse, connect a screen to the GPU's rear I/O, and power the machine on. Hammer the Delete key as soon as you hit the power button, and keep hitting it until you enter the BIOS.

To install Windows, we need to tell the BIOS to boot from the USB stick. Although the location of the boot order varies from mobo to mobo, the procedure is very much the same. In our build, head to the BIOS menu on the top, go down to "Boot Option Priorities," click "Boot Option #1," and select the disk that's labeled "UEFI: Your USB Drive, Partition 1." Hit F10, and select "Save Configuration and Exit." The machine reboots into the USB stick.

You enter Windows Setup at this point. Choose your language, time, and keyboard layout, then hit "Next." Windows then asks for a Windows Activation key – you can either enter this here, or do it later by hitting the "I don't have a product key" button at the bottom. Next, you need to choose the version of Windows you want to install; for us, that's "Windows 10 Home x64." Accept the license agreement and hit "Next." Then, when prompted, hit "Custom Install," and choose your SSD as your primary drive. There are no names here, but each disk does specify its total size, enabling you to select the appropriate drive. Hit "Next." If it throws up an error, or there's a partition already there, delete the partition, and try again. Windows now installs. Once the system restarts, quickly pull out the USB stick, and let Windows finish the install. Now you can select the privacy options right for you, and either log in using your Microsoft profile, or create a localized account.



11 OF DESKTOPS & CHIPSETS

You've made it to the desktop, so what's next? That depends on a few factors. Some motherboards support Ethernet connections automatically, while others require a driver to be installed before even connecting to any network. In our case, it's the latter. So, again on another system (or even on your Android phone, if you're in a pinch), head to your motherboard model's web page (Google your motherboard model – "Gigabyte B360M D3H," in our case – and choose the manufacturer's URL). Then click the "Support" or "Download" tabs, find the "LAN" subsection, and download the relevant driver. Finally, install that on your desktop, and it gives you access to the Internet.

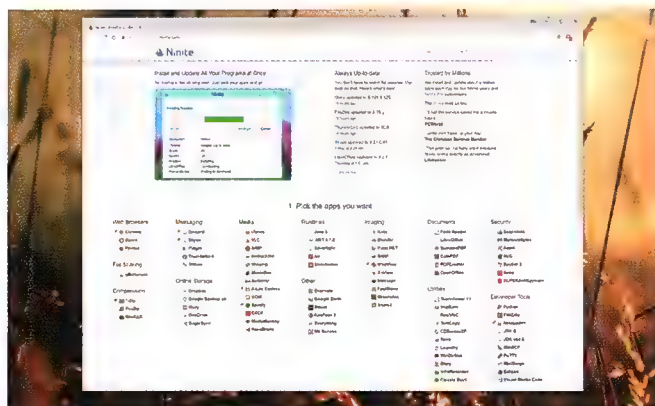
Once this is done, you're going to want to install the remaining drivers. First up is the chipset. From the same website, download the latest version of the chipset, along with any other software, and install it directly on your new system. We recommend that you install the chipset first where possible, before anything else, such as RGB or utility applications provided by the manufacturer, to stop any incompatibilities from occurring.

13 UPDATE THE BIOS

Now it's time to update your BIOS, and get everything ticking along smoothly. Depending on how long your motherboard has been sitting in a warehouse, you might not have the latest BIOS installed.

BIOS updates typically improve stability, weed out bugs, such as Spectre and Meltdown, and can, in some cases, improve performance. Head back to your motherboard's web page, and into "Support." Download the most recent BIOS update, and place it on your desktop. For a BIOS to read an update off storage, the BIOS update file needs to be placed on a memory stick or storage device that has been formatted to the FAT32 file system. Fortunately, your Windows 10 install stick we used earlier already has been.

Plug your Windows install stick into your system, create a new folder inside it called something like "BIOS Updates," take the BIOS update you downloaded, and extract it into this folder. Restart your machine and mash the Delete key to get back into the BIOS. This next step varies, depending on the motherboard (check your manual). In our case, move the mouse to the bottom-right, and a pop-up menu appears. Select "Q Flash," then "Update BIOS," after which you need to find the BIOS folder you made earlier on your memory stick. Select the BIOS file in that folder, and hit the arrow to the right. Your system now starts updating the BIOS. It's imperative at this point that you do not reset or switch off your machine, or you could brick the entire board. Let it do what it has to; it may restart a few times. Once done, head back into the BIOS (we still have work to do).



12 INSTALL YOUR APPS

Now you'll want some regular apps on your rig. A quick starting point is that long-time industry favorite, Ninite. Head to <https://ninite.com> and pick the apps you'd like to install. There's a few we recommend off the bat: Chrome, LibreOffice, Notepad++, and 7Zip. You can also install things such as Skype and Steam if need be, but if, like us, you're a stickler for having all your Steam in a single location, it's arguably better to hold off on that one until later.

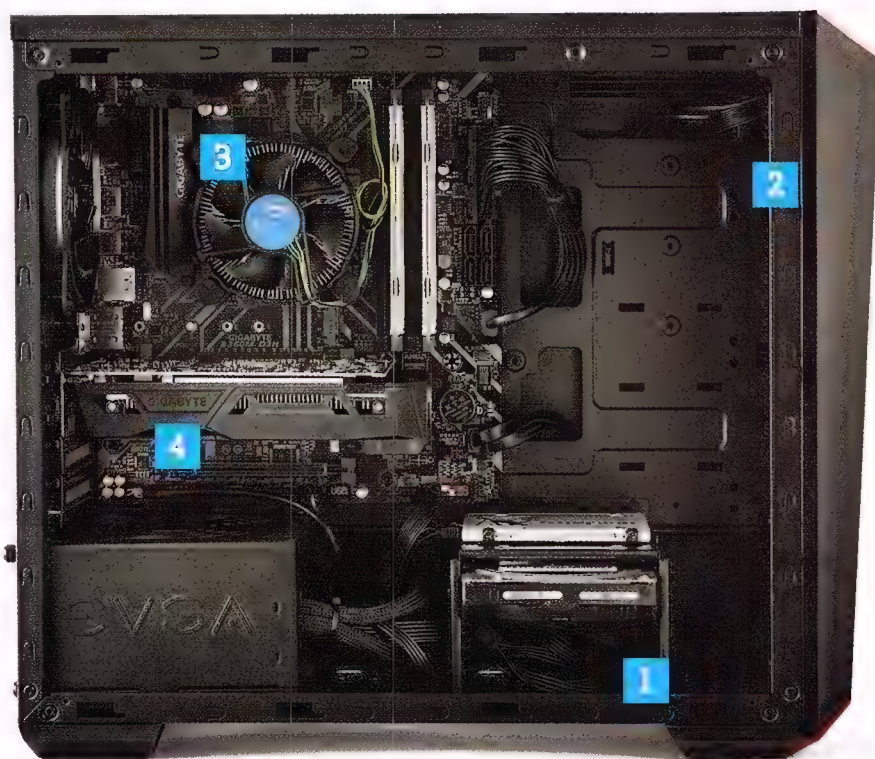
If you watch a lot of media, K-Lite Codex is a good choice. It installs Media Player Classic, which can decode and play MKV video files, among other things. You also need GPU drivers. In our case, Google "Nvidia GeForce Drivers," and click the topmost link. In "Manual Driver Search," select your GPU and OS, hit "Start Search," then download and install the driver. You can opt out of installing GeForce Experience, but then you'll need to do this every few months; GeForce Experience auto-downloads driver updates, but you need to make an account, and give Nvidia some juicy advertising details (we're not fans).

14 PERFORMANCE TWEAKS

There are just a few performance options left to tweak in the BIOS. One of these steps can be ignored, but if you are a perfectionist, getting these last two things done will set your mind at ease, and ensure everything is running as it should be. Head back into the BIOS by hitting the Delete key on restart/startup. First, we'll enable the XMP (Extreme Memory Profile) settings, a pre-set list of specifications that your memory can and will run at, that are typically higher than the JEDEC standard. This means you can transfer more data to and from your memory faster for better performance in memory-intensive applications, such as archiving/zippping, and any photography or editing work you may do. For our Gigabyte board, enter the "Advanced Frequency Settings" option in the main menu, then go down to the "Extreme Memory Profile" menu, press Enter, and choose "Profile 1." This enables the correct timings and frequency for your memory.

You might also want to take a look at fan curves while you're here. You can control these with in-desktop apps, but we always find that BIOS configuration works best, and works from startup. For our motherboard, those settings are found at the bottom of the main BIOS menu. Have a tinker, and find a setup that works for you. That's all there is to it. Then hit F10, save, and exit, and there you have it – one fully working, ready-to-go system.





- 1 Hiding any excess cables under the hard drive caddy here is ideal for keeping things tidy, as long as you don't have more than one 3.5-inch drive, of course.
- 2 There are no intake fans with this build – adding two 120mms in the front of the rig would keep temperatures down, especially during the hot summer months.
- 3 If you're going to upgrade your processor at a later date, remember to get a beefier cooler; this slimline stock one won't cut it.
- 4 We love a GPU that draws power solely from the PCIe bus, although admittedly, it won't be as fast as some of its higher-spec buddies.

A grand of gaming goodness

There you have it: your very own budget 1080p gaming machine. It's versatile, compact, easy to build, and looks darn good, given the limited funds we had. We could have whacked in an Intel Core i3 quad-core part or a GTX 1060 to bolster performance – two very smart moves – but that would mean a bigger budget, and not everyone has that kind of cash lying about.

Was this build a success? Yes. It was never going to compete with our zero-point – that's a \$2,200 machine packing a six-core processor, 16GB of DDR4, a PCIe SSD, and an Nvidia GTX

1060, after all – but for the price, it actually held its ratings fairly well, and despite the lackluster computational performance, the effect on real-world feel and use is slim to minimal.

In game, it's rather different, of course, with most of our tests being almost unplayable in certain circumstances, but this is where we need to get a little granular and explain the whole purpose of our build. With a system like this, you need to be a tweeker. Not necessarily of hardware or overclocking, but of graphical settings. From past experience, we know that when gaming, there are two

effects that take up the majority of your processing power: antialiasing and shadows. Now, in our scenario, you'd be gaming on a 1080p 24-inch panel, so turning off AA in its entirety is a bad idea; reducing it, however, is less so. But let's give you some metrics here.

In our Ultra preset benchmark test for Warhammer II, we managed 27fps. With a few minor tweaks, shadows reduced to minimal, a slight decrease from Ultra to Medium in various textures, and a reduction in foliage/tree quality, we managed 38fps, with minimal impact on overall texture quality. Take that same logic across to *Rise of the Tomb Raider*, and we managed 52fps. Amazingly, there's a setting that renders each individual strand of hair on Lara's head; although it looks breathtaking, during the middle of a game, it's not something we particularly notice.

Perhaps the biggest difference was in *Ghost Recon*. A demanding game at the best of times, dropping the graphical profile down from Ultra to High, and again adjusting the shadow quality (not disabling it entirely), bumped up frame rates from 5 all the way up to 40fps. That's a 700% increase just by tweaking a profile. OK, it's a bit more messing about before playing, but even at the high end, with GTX 1080 Ti and Titans, you still go through the same process anyway, so what's so different down here at the \$1,000 budget? ■

BENCHMARK RESULTS

	APC LABS TEST PC	THIS SYSTEM
CINEBENCH R15 MULTI (INDEX)	1,152	412 (-64%)
CRYSTALDISK QD32 SEQUENTIAL READ (MB/S)	3,400	494 (-85%)
CRYSTALDISK QD32 SEQUENTIAL WRITE (MB/S)	1,720	476 (-72%)
RISE OF THE TOMB RAIDER (FPS)	60	35 (-42%)
TOTAL WAR: WARHAMMER II (FPS)	46	27 (-41%)
TOM CLANCY'S GHOST RECON WILDLANDS (AVG FPS)	39	5 (-87%)
3DMARK: FIRE STRIKE EXTREME (INDEX)	11,101	5,880 (-47%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of an AMD Ryzen 5 1600, 16GB of Crucial Ballistix Sport LT @ 2666, an EVGA GeForce GTX 1060 3GB, and a 250GB Samsung 960 Evo M.2 PCIe SSD. All tests were performed at 1080p at the highest graphical profile.

GEAR OF
apc
THE YEAR

APC'S CRACK TEAM OF TESTERS SELECT
THEIR FAVOURITE PRODUCTS OF 2018

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THE BEST LAPTOPS



■ BEST ULTRABOOK

Dell XPS 13 (2018)

From \$2,099 dell.com.au

Moving the webcam position, adding facial login and a four-mic array, giving Intel's chips more headroom to perform even better and adding a 4K screen have all evolved the XPS into an even more formidable flagship laptop. In directly addressing the concerns of users, the Dell XPS 13 laptop is refined further than ever before. With all of the improvements made to the XPS 13 for this year, the rest of the laptop world had a lofty benchmark to measure itself against.



■ BEST BUDGET GAMING LAPTOP

Acer Nitro 5 (NH.Q3XSA.001-C77)

From \$1,499 acer.com.au

While there are a handful of laptops in the budget space that offer great gaming solutions for those who are tight on cash, the Acer Nitro 5 is this year's budget-laptop to beat. Whether it's the entry level offering that doubles the RAM allocation to 16GB and throws in an additional 16GB of Intel Optane system memory, or it's the \$1,799 option offering a Nvidia GTX 1060 GPU, the Acer Nitro 5 is really showing up the competition in the budget gaming space.



■ BEST PREMIUM GAMING LAPTOP

Aorus X7

\$4,199 aorus.com

Aorus is the premium gaming subsidiary of Gigabyte. Both the X5 and X7 units are decent value for their powerful components, but the latter gets an overclockable Intel Core i7-8850H CPU, a 17.3-inch FHD 144Hz display with G-Sync, a Nvidia GeForce GTX 1080 GPU, 16GB of RAM, a 512GB PCIe connected SSD and a 1TB HDD.



■ BEST BUDGET LAPTOP

HP 250 G6

\$539 hp.com/au

HP's 250 G6 laptops are available in a variety of specs, but we reckon this Core i3-6006U model strikes the best balance between price and performance – although if you can stretch to the \$690 Core i5-7200U model, that's a worthy upgrade, especially if you plan on doing multimedia work like image or video editing. You still get all the basics with this i3 model though, including a serviceable 15.6-inch LCD, 500GB HDD, 4GB of RAM, Wi-Fi, Bluetooth and a built-in webcam. Ably does the basics, but not a lot more.



■ BEST PREMIUM LAPTOP

Gigabyte Aero 15X

From \$3,399 gigabyte.com/au

The Gigabyte Aero 15X is an excellent gaming laptop with proper media work chops as well, with a sleek premium package that should impress users in both realms. With a great battery life, balanced performance and affordable price, the tightrope the Aero 15X walks is an alluring one. If you're looking for the most affordable Max-Q GTX 1070 gaming laptop, you've found it – and it plays just as well as the pricier ones (plus, we've seen it discounted by more than \$500 a few times).



■ BEST CHROMEBOOK

Asus Chromebook Flip

\$899 asus.com/au

Although Chromebooks are still a little bit foreign to Australian shores, the Chromebook Flip from Asus is the unit to beat. It's definitely worthy of its premium stature with a gorgeous screen, tactile keyboard and a classy design that's equally as comfortable to use in tablet mode or as a traditional laptop, even outdoing most of the competition in either of those two categories. If you're willing to drop a few more dollars on a premium 2-in-1, the Chromebook Flip is the go.

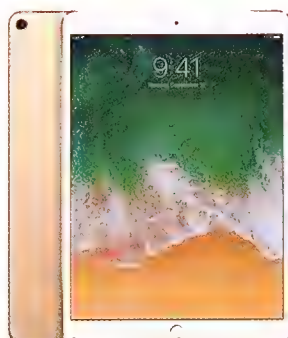


■ **BEST BUDGET TABLET**

Galaxy Tab A 10.5-inch (2018)

From \$359 | samsung.com/au

Sharing the same size display and 7,300mAh battery as the higher tier Galaxy Tab S4, Samsung's 10.5-inch Galaxy Tab A is terrific value for money for those who want a good quality tablet experience without breaking the budget. In terms of specs, it's got a 1080p LCD panel, a mid-tier Snapdragon 450 processor, 32GB of onboard storage and 3GB of RAM, which is pretty decent when you consider its astonishingly affordable price tag.



■ **BEST IOS TABLET**

Apple iPad Pro 10.5-inch

From \$979 | apple.com/au

The 10.5-inch iPad Pro is a stunning machine in many ways. The speed and raw power on offer when doing pretty much any task on it can't be understated, and the upgrades to the screen are just beautiful at times. Even after more than a year, it's still our top pick, balancing price, portability, and features. Easily outpacing the basic iPad, the iPad Pro is absolutely worth picking up.



■ **BEST WINDOWS TABLET**

Microsoft Surface Pro 6 (2018)

From \$1,349 | microsoftstore.com

It should come as no surprise that this year's Surface Pro is the most powerful yet. Much of that comes through the introduction of quad-core processing, thanks to Intel's 8th generation Kaby Lake Refresh processors released earlier this year. This is certainly a better product than the last, but only barely so. If you already own a Surface Pro 2017, you could probably just stick with that. That said, it's still 2018's best Windows tablet.



■ **BEST ANDROID TABLET**

Samsung Galaxy Tab S4

From \$979 | samsung.com/au

Samsung's Galaxy Tab S4 is an upgrade over the Galaxy Tab S3 with an expanded 10.5-inch screen size and longer battery life, but it comes at a higher price and isn't exactly ideal as a true desktop replacement. That said, it's still a brilliant tablet, with a sleek design and gorgeous Super AMOLED display. Sure, the Tab S4 is better than the Tab S3, but if you already have that tablet, you probably don't need this one.



■ **BEST BUDGET 2-IN-1**

Microsoft Surface Go

From \$599 | microsoft.com

Microsoft's new Surface Go take a lot of the best elements from the Surface Pro line and repackaged them in a budget 2-in-1 form factor. Starting at around \$599, the Surface Go puts a lot of pressure on the budget end of the 2-in-1 market. What's perhaps the killer feature of the Surface Go is Windows 10S, which allows the Windows Store-only operating system to run really well on CPUs that are about half as powerful as a 2-in-1 running a Core i5 CPU.



■ **BEST PREMIUM 2-IN-1**

Microsoft Surface Pro 6

From \$1,549 (With Type Cover) | microsoft.com

Microsoft have added quad core processors to the Surface Pro 6 range that make the i5 over 44% more powerful than the i7 Surface Pro and effectively double the CPU power on like for like devices from last year. While the Type Cover and Surface Pen are optional extras, these are still the best 2-in-1 accessories on the market and despite the lack of a USB-C port the new device's USB Type-A, DisplayPort and headphone jack tick off all the essentials (and there's always the option to buy a Surface Connect dock).



■ BEST ULTRABOOK

Dell XPS 13 (2018)

From \$2,099 dell.com.au

Moving the webcam position, adding facial login and a four-mic array, giving Intel's chips more headroom to perform even better and adding a 4K screen have all evolved the XPS into an even more formidable flagship laptop. In directly addressing the concerns of users, the Dell XPS 13 laptop is refined further than ever before. With all of the improvements made to the XPS 13 for this year, the rest of the laptop world had a lofty benchmark to measure itself against.

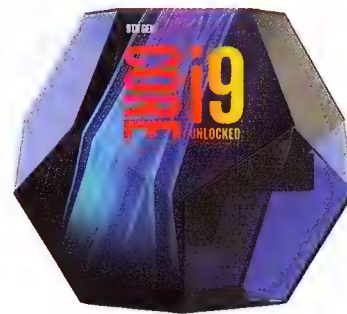


■ BEST MAINSTREAM CPU

AMD Ryzen 7 2700X

\$478 amd.com

The Ryzen 7 2700X's multi-threaded muscle makes it a natural fit for application workloads. The Ryzen 7 2700X's eight cores and 16 threads crunch through heavily-threaded workloads with ease due to the 3.7GHz base and 4.3GHz boost frequencies. AMD also improved the multi-core boost algorithms and reduced memory latency, which equates to a big step forward on the performance front.



■ BEST PREMIUM CPU

Intel i9-9900K

\$859 intel.com

Unless you regularly use heavily-threaded applications, it's hard to justify stepping up to Core i9-9900K from any modern four- or six-core CPU. With that said, Core i9-9900K is the fastest mainstream processor on the market. Plenty of enthusiasts opt for the best possible performance in both single- and multi-threaded workloads at any price. There, the Core i9-9900K doesn't disappoint.



■ BEST EXTREME CPU

AMD Ryzen Threadripper 2950X

\$1,415 amd.com

While we still recommend the mainstream Ryzen 7 2700X or Core i7-8700K for gaming, they clearly can't keep pace with Threadripper in productivity-oriented applications. Intel's Skylake-X processors are still brutally fast, but you'll also pay a premium for the privilege of owning one. The Threadripper 2950X offers a lot more performance at a lower price than the first-gen Threadripper did at launch.



■ BEST EXTREME GPU

Nvidia GeForce GTX 2080 Ti

\$2,100 nvidia.com

Looking to blow the budget on a top-level card? Well, you can't really put a foot wrong with the 2080 Ti. With AMD seemingly content to focus on the midrange and entry-level markets at present, there's nothing from the red team that can compete. If you're gaming at 4K or on a larger ultrawide, a single 2080 Ti can net you over 100fps average in most games. If money's no object, this one's an easy recommendation.



■ BEST PREMIUM GPU

Nvidia GeForce GTX 1080 Ti

\$1,150 nvidia.com

Pick one up for a bargain now that the 2080 is out and enjoy enough power to run almost anything on high detail. Enthusiasts with VR headsets need to achieve a certain level of performance to avoid jarring artifacts. A GeForce GTX 1080 Ti is fast enough to keep up with the 90Hz refresh rates of modern HMDs. Moreover, it includes a number of features designed to improve the efficiency of rendering VR environments.



■ BEST MAINSTREAM GPU

Nvidia GeForce GTX 1070 Ti

\$620 nvidia.com

Nvidia's GeForce GTX 1070 Ti gives us very little to gripe about. It's an excellent card for gaming at 2560x1440. Not only does it use less power than AMD's competing Radeon RX Vega 56, but also the lower-end Radeon RX 580. The 1070 Ti's high performance, cool temperatures, and quiet fans were revolutionary when it launched in 2016. At just over \$600 it's a steal considering the performance on offer.



■ BEST BUDGET GPU

Nvidia GeForce GTX 1050 3GB

\$244 nvidia.com

Nvidia's GeForce GTX 1050 3GB is mostly an upgrade over the 2GB version, offering reasonable performance at 1920x1080 (so long as you're willing to dial back quality). Recently, examples of the 3GB card began showing up for sale at about \$10 higher than Radeon RX 560. Consistently better frame rates mean we're willing to spend a bit more money for the GeForce GTX 1050 3GB card.

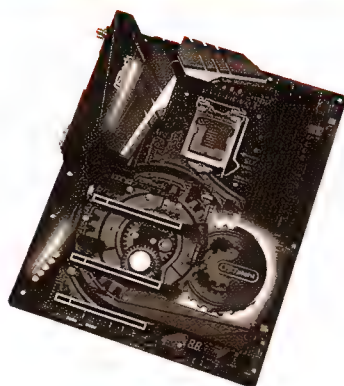


■ BEST BUDGET INTEL MOTHERBOARD

Asrock H370M Pro4

\$139 asrock.com

The Asrock H370M Pro4 brings Intel's more-advanced H370 feature set to buyers who thought they could only afford a lesser B360 model. Those who don't need RGB or a 10Gb/s USB 3.1 Gen2 front-panel header will be pleased to find that the H370M Pro4 offers more of nearly every other port than its closest competitor, for a lower price.



■ BEST MID RANGE INTEL MOTHERBOARD

Asrock Z390 Taichi

\$399 asrock.com

The reputation of the Asrock Taichi series continues to be enhanced. It looks good and has a core feature set that mostly matches the higher end boards. Overclocking and performance numbers are dead on what we expect from a now mature platform. If you're on a budget, and wish to divert some extra dollars towards a bigger SSD or better GPU, then the Z390 Taichi should definitely be on your radar.

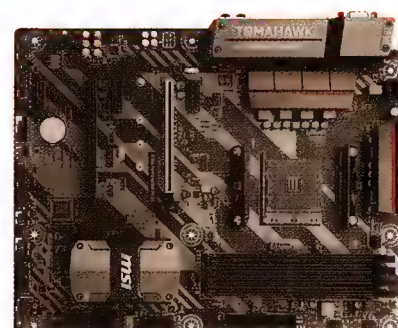


■ BEST PREMIUM INTEL MOTHERBOARD

Asus Maximus XI Formula

\$729 asus.com/au

The Asus Maximus XI Formula comes across as a really refined board that's tailor made for watercoolers and modders looking to show off their rigs. We love the OLED panel, cooling options, build quality and networking prowess. There's no doubt it's a pricey proposition but it's the kind of price that's justified thanks to its unique and innovative feature set.



■ BEST BUDGET AMD MOTHERBOARD

MSI B350 Tomahawk

\$145 au.msi.com

It is fairly frugal: Realtek ALC892 codec, Realtek 8111H ethernet, and only four SATA ports, but it does come with Type-C, support for RGB LEDs, and the audio has some base upgrades. MSI's software and BIOS packages have improved over the last few years too, so pairing this with an AMD Ryzen 7 processor in the sales could mean an 8-core gaming processor and motherboard combo for around under \$600 and change. That is mind boggling compared to a few years ago.



■ BEST MIDRANGE AMD MOTHERBOARD

Gigabyte X399 Aorus Gaming 7

\$469 asus.com/au

If RGB bling and lots of fan headers are key to your Threadripper build, this Aorus X399 board surpasses other X399 offerings. Excellent performance and overclocking capabilities, improved UEFI functionality, and a deep feature set also help hoist it above the competition.



■ BEST PREMIUM AMD MOTHERBOARD

MSI MEG X399 Creation

\$769 au.msi.com

The MSI MEG X399 Creation is clearly designed to please more than just content creators and professional users, especially given the tools and features included. Overall MSI has done a great job with the MEG X399 Creation, thanks to a mixture of good design choices such as the numerous 4-pin fan headers and the heatsink-covered M.2 slots. The aesthetics are unique and the creative explosion-inspired look with more RGB than you can shake a stick at makes this a desirable offering.



■ BEST MINI-ITX MOTHERBOARD

Asus ROG Strix X370-I Gaming

\$229 asus.com/au

Asus knocks it out of the park with the ROG Strix X370-I Gaming when it comes to Mini-ITX form factor motherboards. If money is no concern and building a water-cooled small form factor box is the goal, this Asus surpasses other boards.

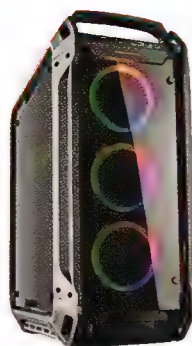


■ BEST BUDGET PC CASE

Thermaltake Versa J25 TG RGB Edition

\$99 thermaltake.com.au

Budget cases don't always look that exciting – after all, you've got to give up something to bring in a case for around \$100! But, somehow, Thermaltake's managed the impressive feat of bringing a \$99 case to market that punches way above its weight in the looks department. With three fans mounted in the front panel it's a handy cooler, too, and tempered glass sidepanel lets you show off all your gaming gear.

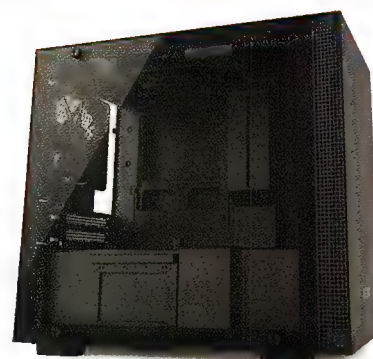


■ BEST PREMIUM PC CASE

Cougar Panzer EVO RGB

\$279 cougargaming.com

Aggressive styling? Check. Tempered glass panels? Check. Packed with fans sporting RGB functionality? Check. It looks as though Cougar's new Panzer EVO RGB chassis is an upgraded version of the Panzer EVO with RGB options galore. Dubbed the "RGB Crystalline Titan" this chassis not only features dynamic styling and fancy RGB lighting, it has outstanding cooling performance and more than enough space for even the largest of PC builds.



■ BEST MINI-ITX PC CASE

NZXT H200i

\$159 nzxt.com

Although the H200i's price tag doesn't exactly make it a budget case, it is one of the best performing Mini-ITX cases we tested in well over two years. That said, we feel the H200i's strong performance-per-dollar value, coupled with its good-looking steel and tempered glass design, and its included RGB lighting and fan control make it an excellent product deserving of a place in our best tech of the year.



■ **BEST GAMING MONITOR**
Acer Predator X34P
\$1,399 acer.com

There is little to dislike about the Acer Predator X34P. It has G-Sync and 120Hz support wrapped up in a 1900R-curved IPS screen with accurate color and good contrast, made even better by a unique approach to gamma that works extremely well. It's better-looking than its predecessor, and speedier too.



■ **BEST PROFESSIONAL MONITOR**
DELL U3415W
\$1,200 dell.com

Curved monitors may still leave some buyers scratching their heads, but in our opinion, they're quite useful and worth the extra money. The U3415W offers quality and accuracy that easily justify its price, so we consider the ultra-wide aspect and curved screen to be bonuses. We have no trouble recommending this one to professionals or enthusiasts alike.



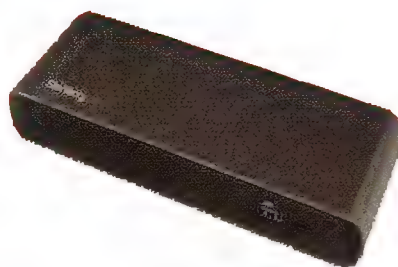
■ **BEST BUDGET MONITOR**
AOC Q3279VWFD8
\$299 au.aoc.com

A mammoth 31.5 inches in size, all of it a quality IPS panel at a game-friendly 2560x1440 resolution for under \$300. The refresh rate of 75Hz is reasonable, especially at this price. FreeSync support helps keep the price down and makes this a great choice for AMD GPUs, but really for \$300 any Nvidia owner would get great satisfaction from this beauty, too.



■ **BEST LAPTOP MOUSE**
Logitech MX Anywhere 2S
\$90 logitech.com

Logitech's push this year was to add cross-computer compatibility to its wireless keyboards and mice, which made our favourite laptop mouse even more appealing. It's \$10 more than last year's MX Anywhere 2, but the added multi-computer compatibility allows seamless scrolling across PCs as if they're screens on the same system, so it's worth a bit extra in our eyes.



■ **BEST USB LAPTOP DOCK/HUB**
StarTech thunderbolt 3 dual-4k docking station
\$399 startech.com

Often, docking stations require multiple leads, but StarTech's latest offering avoids that. The device has been designed to work with thinner notebooks and uses only one cable. As the name suggests, it supports dual 4K displays (at 60Hz) and harnesses the power of Thunderbolt 3, offering 40Gbps bandwidth while keeping portability in mind. That's not all, though. It can be used with up to three USB 3.0 devices and you also get Gigabit Ethernet capability.



■ **BEST PROFESSIONAL MOUSE**
Logitech MX Master 2S
\$149 logitech.com

The Logitech MX Master 2S is one of the best mice you can buy today, especially if you need to get some work done. The Logitech MX Master 2S is created for one thing, and one thing only: productivity. Trust us, you might not think you need a high-end wireless mouse for your day-to-day office work, but once you use this mouse, with its ergonomic grip and buttons and dials you can program for anything you'll never want to go back.



■ BEST PRINTER (BUDGET)

Canon Pixma MG2960

\$36 canon.com.au

The Canon PIXMA MG2960 inkjet can print, scan and copy in colour, plus send faxes. It has USB and Wi-Fi that supports the Pixma printing app, Apple AirPrint and Google Cloud Print. The unit boasts a 4,800 x 1,200DPI resolution, and can handle up to 100 sheets and prints at 8.8ipm B&W, and 4.4ipm in colour. Perfect for documents, and only okay for photos. The scanner has autofeed functionality and can make copies of up to 99 pages in one batch.



■ BEST PRINTER (MID-RANGE)

Epson WorkForce Pro WF-4630

\$229 epson.com.au

The WorkForce Pro WF-4630 is a solid printer for small businesses and workgroups given its fast print speeds, solid print qualities and remote printing and scanning capabilities. Using the larger XL print cartridges, the WF-4630 delivers economical print costs that rival laser printers. Unless your office requires heavy photo print jobs, the WF-4630 is an excellent choice.



■ BEST WEBCAM

Logitech C922 Pro Stream

\$149 logitech.com

Logitech's newest webcam, the Logitech G922 Pro Stream features the same classy design as the C920 before it, but it's especially interesting for gamers this time around. The C922 still boasts excellent 1080p video quality when it comes to hosting video calls, and its automatic low-light correction makes it a great cam for streaming with the lights off. It also supports background removal, making it ideal for budding YouTubers.



■ BEST GAMING KEYBOARD

Corsair K70 RGB MK2

\$215 corsair.com

Built around a solid piece of attractive aluminium, the Corsair K70 RGB MK.2 is a board that can take some abuse. The keys feature the usual RGB lighting, though this is easily controlled from the board itself, and can be tweaked handily via Corsair's excellent iCUE software which can also be used for macro-recording. The Corsair K70 RGB MK.2 also boasts 8MB of onboard storage. The keys are responsive, and come in a full range of Cherry varieties.

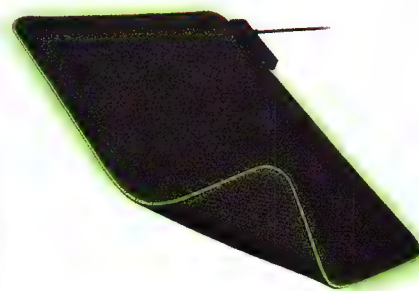


■ BEST GAMING MOUSE

Razer DeathAdder Elite

\$109 razerzone.com

While this series has always been popular with us, an updated 16,000DPI optical sensor adds a new level of fidelity to this already exceptional gaming mouse. This year's new mechanical switches are a little quieter and feel nicer than previous offerings. It's still on the lighter side at 105g, but with a DPI toggle, mappable thumb buttons and all the customisable RGB lighting you'd expect it's still our top pick of the gaming mice.



■ BEST GAMING MOUSE PAD

Razer Goliathus Chroma Soft

\$59 razerzone.com

A good mousing surface is critical, and no your desk isn't good enough. Razer's soft Chroma changed our mind about soft mouse pads, offering extremely precise tracking and a smooth and speedy feeling of movement. Set the edged RGB to something cool, like a single colour at low intensity that matches your RGB mouse, and it really does look rather marvellous in a darkened room.



■ BEST WIRELESS GAMING MOUSE

Logitech G903

\$169 logitech.com

The Logitech G903 Lightspeed tries to do everything, and actually manages to pull it off. It's a wonderfully sculpted ambidextrous design that fits a left hand as comfortably as any right-handed mouse, but can also accommodate lefties and has removable thumb buttons for either configuration. It has a brand new click mechanism that feels and sounds better than any other mouse we've used.



■ BEST GAMING HEADSET

Corsair HS70

\$159 corsair.com

The HS70's virtual 7.1 surround sound actually does its job very well, delivering clear positional audio at all virtual distances, and at a great price point for such a strong showing. Right now, these are probably right in the sweet spot for price and performance, and if you're in the market for a new set of gaming 'phones (that also work with a PS4), you can't go wrong.



■ BEST GAMING CAPTURE CARD

Razer Ripsaw

\$229 razerzone.com

The Razer Ripsaw is one of the few capture devices targeted at providing a solution for the gamer looking to record from anything to everything. You can plug the Ripsaw in and play straight from one rig into another. And it's fairly painless to set up. Our testing found the Ripsaw wonderfully consistent, with recordings crisp and sharp. Despite not having the option of capturing footage above 1080p, using the Ripsaw makes for a surprisingly enjoyable experience.

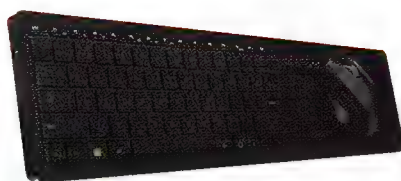


■ BEST VR FOR PC

HTC Vive

\$939 vive.com

When it originally released, the HTC Vive was streets ahead of its nearest competitor, the Oculus Rift. Now, however, the gap has narrowed. Today the Oculus Rift matches much of the Vive's functionality and includes two motion controllers of its own. But the Vive still has the edge over the Oculus because, for our money, the room-scale tracking is that much better, adding another dimension to the feeling of presence that you experience while using it.



■ BEST LAPBOARD

Razer Turret

\$279 razerzone.com

While there are arguably better lapboard typing experiences to be found for the same price, the Turret from Razer is a compact unit that gives you all the essentials without dominating your living room. Sadly, you won't be able to dim your living room lights, as the Turret misses out on any backlighting, but this does allow for a totally wireless experience, an attribute that is surprisingly rare in lapboards. To top it off the mouse and keyboard's rechargeable batteries will last around 40 hours, which is more than enough to be convenient.



■ BEST PC GAMEPAD

Razer Wolverine Ultimate

\$199 razerzone.com

The Razer Wolverine Ultimate has only one audience in mind: the really hardcore, couch-based gamers. It's not ideal if you're sitting further than 10 feet away from your monitor or TV or necessary for those who enjoy single-player campaigns more than they enjoy the thrills of online competition. If you don't care to have the option of wireless and can stomach the asking price, the Razer Wolverine might otherwise be one of the best constructed – and best looking – controllers ever made.

THE BEST NETWORKING



■ BEST MESH SET

Netgear Orbi (Kit of Two, RBK50)

\$555 netgear.com.au

Despite it being one of the first sets available, this Orbi two-device kit remains our favourite mesh product. That's partly because Orbi has a dedicated wireless 'backchannel' for the devices to communicate with each other, meaning your laptop/smartphone/gaming-console or other traffic doesn't get jammed up and which helps to boost speeds and overall signal strength. It's also simple to set up, and additional satellites can be purchased individually.



■ BEST PREMIUM BROADBAND ROUTER

Netgear Nighthawk XR500

\$400 netgear.com.au

Although Netgear reckons this a 'gaming' router, it's great at just about everything and has all the high-end features you could ask for, including premium AC2600 802.11ac Wi-Fi with 4x4 MU-MIMO, four Gigabit Ethernet ports and one Gigabit WAN, a beefy dual-core 1.7GHz Qualcomm CPU and a custom DumaOS. The latter is simple to use and lets you monitor traffic in real time and easily prioritise specific devices' access.



■ BEST BUDGET BROADBAND ROUTER

Synology RT1900ac

\$180 synology.com

Synology is a name better known for network-attached storage than routers, but it's been dabbling in this space for a few years now, and this 802.11ac router is our current pick if you need a robust device that won't break the bank. It's one of the more-affordable AC1900 routers on offer and uses a unique Synology router OS that drastically increases its featureset and lets you install apps to add new functions. Despite that, it's also still easy to use.



■ BEST PREMIUM ADSL/VDSL ROUTER

Netgear Nighthawk X8 D8500

\$590 netgear.com.au

With full 4x4 802.11ac MU-MIMO tri-band Wi-Fi, six Gigabit Ethernet ports and built-in ADSL/VDSL modem, this do-all router is a powerhouse that's ready for any internet connection type – there's even a WAN port in case you want to switch to cable or FTTP NBN. Its easy to set up and use, with first-rate site-blocking and media-serving features, plus advanced QoS to ensure there are no interruptions when you're gaming or streaming videos.



■ BEST BUDGET ADSL/VDSL ROUTER

TP-Link Archer VR600

\$180 tp-link.com.au

Over the last five or so years, TP-Link's become the go-to brand for lower-cost routers of all kinds, and this AC1600 Wi-Fi model provides steady wireless connectivity and all the essential features that most users need, including 1300Mbps 5GHz Wi-Fi with beamforming, the ability to re-use one of its four Gigabit Ethernet ports to connect an external modem (so you're covered for any type of NBN connection), a Broadcom chipset and even 3G/4G USB modem support in case your main connection goes down.

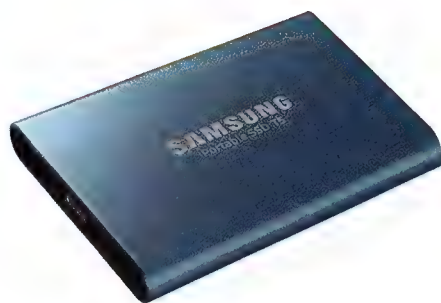


■ BEST POWERLINE KIT

TP-Link TL-PA8010P

\$125 tp-link.com.au

Powerline kits haven't changed much since last year, so our recommendation remains as this 1,200Mbps two-pack, which uses 2x2 MIMO tech and all three power wires. In real world testing, that gave us 221Mbps up and 219Mbps down – still the fastest of any other PowerLine device we've reviewed, and it connected over longer distances than most others too. Installation is simple – plug them in where you need them and hit the pairing buttons.



■ BEST PORTABLE STORAGE (PREMIUM)

Samsung Portable SSD T5

From \$129 samsung.com/au

Samsung's been the one to beat in portable flash-based storage for some time now and despite not updating the T5 this year, the incremental price drops have kept it ahead of any new competition. You can actually get faster read and write speeds from the company's new X5 portable SSD, but when it starts at \$550 for 500GB, it's a bit too pricey to appeal to everyone. The T5's 437/444 Mbps read and write speeds will be good enough for most.

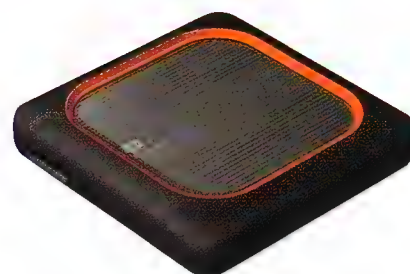


■ BEST PORTABLE STORAGE (BUDGET)

WD My Passport

\$89 wdc.com

If you can live with the read and write speeds of hard drives then portable storage has never been cheaper. WD's My Passport range are good all rounders, balancing price, size and capacity and while you can still find elemental drives for a similar price or less, WD's My Passport range come with security and backup software bundled in. Sustained read and write speeds of 114.5/110.1 Mbps, mean it isn't the fastest, but it's more than serviceable for most.



■ BEST WIRELESS PORTABLE STORAGE

WD My Passport Wireless SSD

From \$429 wdc.com

WD's wireless portable hard drive range has been pitched at hobbyist and professional photographers and cinematographers for some time now and so the new My Passport Wireless SSD seems like the natural progression in this range. Starting at \$429 for 250GB, it costs a bomb, but if you have fast cards for your camera and a genuine need to move a lot of pictures around the the speed of an SSD justifies the price.

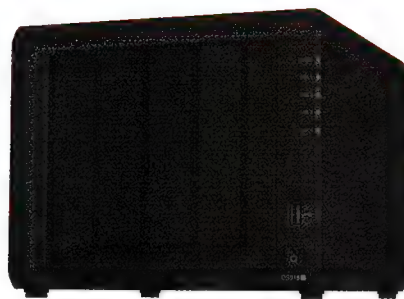


■ BEST TWO-BAY NAS BOX

Synology DS218j

\$270 synology.com

The J series of drives from Synology denote that they're more affordable products – which for us, is exactly what you want in a two-bay NAS. It still supports mammoth hard drives up to 14TB (for a total of 28TB), meaning you can still cram heaps of files and backups on board, although its CPU and RAM combination (a dual-core Marvell chip with 512GB of memory) does limit its transcoding capabilities and it can't run virtual machines.



■ BEST FOUR-BAY NAS BOX

Synology DS918+

\$760 synology.com

The successor to the four-bay NAS we've recommended for the last two year (the excellent DS916+), this newer model still includes fast internals including a quad-core Celeron J3455 CPU and 4GB of RAM, making it a great choice for more demanding users – like those who want to run a Plex media server and transcode videos for playback on multiple devices around the house (or even over the internet, if you've got a fast NBN connection).



■ BEST FIVE-BAY (OR BIGGER) NAS BOX

Synology DS1618+

\$1,100 synology.com

Synology swept the board for this year's NAS recommendations – and that's largely because of their excellent DSM operating system, which lets you install a wide range of extra apps and services to customise your device to meet your exact needs. If you need a NAS with epic storage capabilities, this six-bay unit is our top pick, with support for 14TB hard drives (for a total of 84TB) and powered by a speedy quad-core 2.1GHz Atom C3538 processor combined with 4GB of RAM.

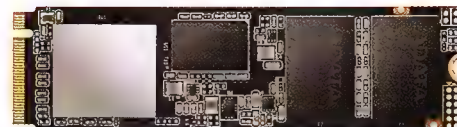


■ **BEST INTERNAL SSD (PREMIUM)**

**Samsung 970 Pro
(1TB, NVMe)**

\$625 samsung.com/au

You can still have the performance and endurance benefits of MLC flash, and it comes at only half the price of the Intel Optane 905P. The Samsung 970 Pro is still an expensive option, but it is also the last consumer NVMe SSD that comes armed with durable MLC flash for enhanced performance consistency.



■ **BEST INTERNAL SSD (MID-RANGE)**

**Adata XPG SX8200
(480GB, NVMe)**

\$189 adata.com

For its price point, the 480GB Adata XPG SX8200 is impressively fast during normal applications and game loading. The SX8200 carries the same RRP as similar SSDs, but it has a larger SLC buffer to absorb more write data at one time. The dynamic buffer maintains higher sequential write performance for longer, but this isn't a workstation SSD. Adata is known for updating its firmware as the SSD matures, which improves the great performance even more.



■ **BEST INTERNAL SSD (BUDGET)**

**Samsung 860 Evo
(256GB, SATA)**

\$75 samsung.com/au

At less than \$100, it is difficult to overlook the 250GB Samsung 860 EVO. It delivers excellent performance and offers class-leading endurance for the mainstream SATA SSD market. Samsung's software package adds to the value and even features a DRAM caching option that increases performance in frequently used applications.



■ **BEST INTERNAL NAS HARD DRIVES**

Seagate IronWolf

From \$100 seagate.com

It's a little unfortunate that the Seagate IronWolf NAS drives come at a premium, but they aren't priced much more expensively than a standard hard drive at their capacity. However, their native NAS optimization makes that cost totally worth it. These drives are capable of running at a fast 7,200rpm spin rate 24/7 without having to worry about drive failure. Really, if you have one of the best NAS devices for your business or home, the Seagate IronWolf NAS really is your best bet.



■ **BEST EXTERNAL DESKTOP STORAGE (PREMIUM)**

WD My Book Duo 20TB

\$999 wdc.com

Storage space is cheap enough these days that even if you need a tonne of it, you might as well buy that little bit more and run an external hard drive in a RAID 0 format to double the speed at which they can read and write. Demonstrating this is WD's My Book Duo which comes preformatted to be twice as fast as conventional HDDs out of the box. With units available up to the 20TB mark, they're not gonna be short on space.



■ **BEST EXTERNAL DESKTOP STORAGE (BUDGET)**

Seagate Backup Plus Hub 4TB

\$169 seagate.com

The front-facing dual USB 3.0 ports on this desktop drive are the distinguishing feature, allowing easily accessible charging or quick backup connections, but the Backup Plus Hub also excels in many other ways. Read and write speeds are 198/188MB per second respectively which makes it much faster than average external HDDs and it looks much sleeker than the alternatives.



Youtube Music

Free with IAP music.youtube.com

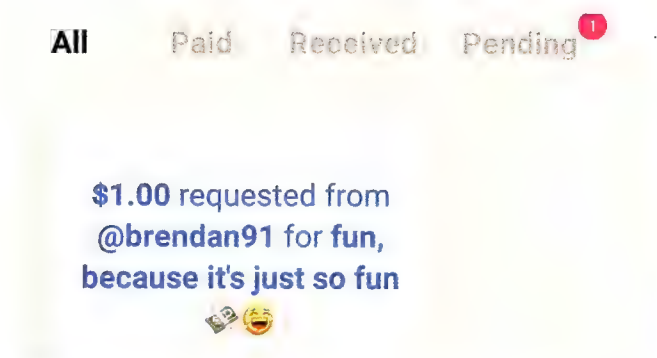
Google's long overdue revamp to Youtube Music features AI tuned playlists, video, chromecast support and a custom auto-generated offline playlist based on your activity. Requires Youtube Premium.



Wish

Free | wish.com

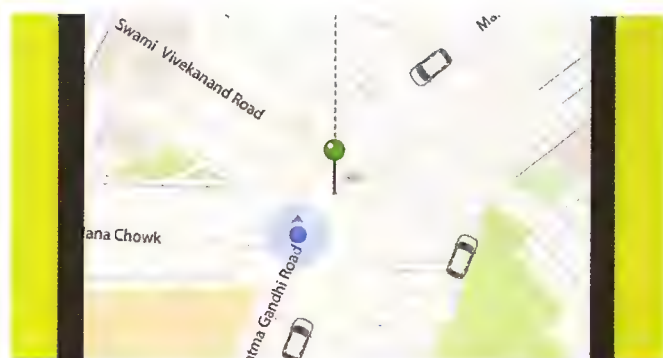
If you want cheap... anything.. Wish is a must have shopping experience. Millions of products, absurdly cheap pricing and shipping. Warning, quality may vary, but that's part of the fun.



Beem IT

Free beemit.com.au

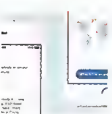
Beem IT allows instant and easy payments to anyone with an Australian mobile number. Split a dinner bill or pay back for a sixpack, or send requests for a payment.



Ola

Free ola.com

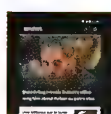
A new alternative to Uber, Ola offers drivers a fairer commission system as well as cheaper prices and regular discounts. Availability is wider although the app isn't as slick or featured as Uber.



Quartz

Free quartz.com

One of the most innovative news apps out there, Quartz gives you the latest in news via a text style interface, complete with emoji and gifs. A must try experience that works for those who want to keep informed on the go.



ABC News

Free abc.net.au/news

The ABC App is now just ABC News, which has cut out a lot of the other ABC services into their own standalone apps. What is left is a much more refined, news centric experience, including access to live radio/TV news streams.



Raiz

Free raiz.com.au

Want to invest but don't have the wealth? Raiz allows you to automatically invest your cents rather than your dollars, allowing them to sit on the stock market and pool into a tidy sum.



BlueMail

Free bluemail.com

Bluemail is one of the better looking universal mail apps out there, and features a lot of features like snoozing that are missing from a lot of other native mail applications. It also works across both iOS and Android, syncing along the way.



The Weather Channel

Free with IAP
weatherchannel.com

Still the best cross platform weather app out there, with a beautiful refined interface, global 15 day forecasts and notifications for rain and disaster alerts. Ad supported unless you pay \$1.39/month.

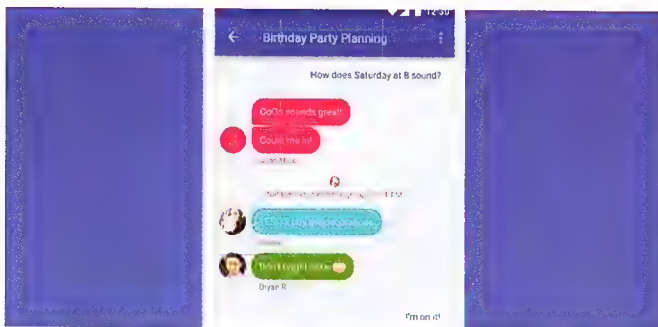


GBoard

Free google.com

Google's keyboard includes everything you need, from access to assistant, gifs, stickets, emotes, Swift Key and pretty much everything else under the sun. It has a decent autocorrect and a customisable layout.

THE BEST ANDROID APPS



Google Messages

Free [messages.android.com](https://play.google.com/store/apps/details?id=com.google.android.messaging)

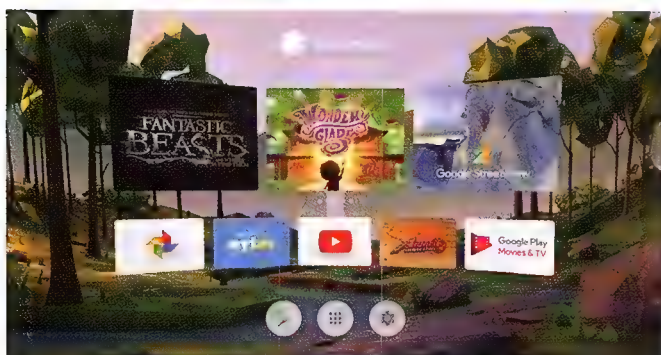
Google's Messages has evolved rapidly over the past year and is now hands down the best SMS app on the platform, with new support for RCS, search, AI quick replies, a new fresh interface alongside a very handy web app.



Microsoft Launcher

Free [microsoft.com](https://play.google.com/store/apps/details?id=com.microsoft.launcher)

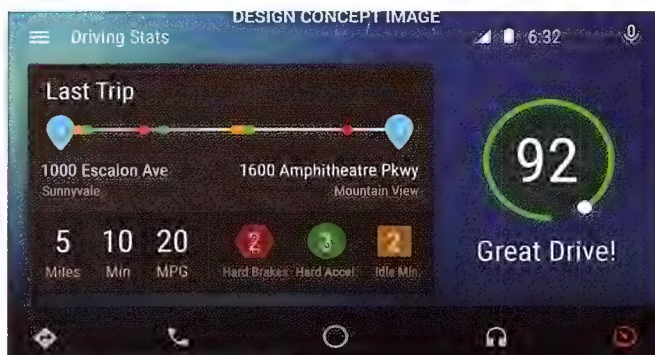
Microsoft has surprisingly pulled out the stops with its Android launcher which effectively turns your device into a fully Microsoft experience. It's smooth, quick, useful and very customisable. Great for anyone who primarily uses MS services.



Daydream

Free (Requires Hardware) [daydream.com](https://play.google.com/store/apps/details?id=com.google.daydream)

VR on Android has evolved over the past few years to be surprisingly good, and Daydream is easily the best rendition of it. The 2018 headset is great and there are heaps of great apps and games to play.



Android Auto

Free [android.com](https://play.google.com/store/apps/details?id=com.google.android.auto)

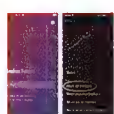
Got that dodgy or stock head unit in your car? Android Auto turns your phone into a driving optimised device, with easy simplified touch controls for music, navigation and phone. Assistant is also there for handsfree use.



Bouncer

\$1.39 [play.google.com](https://play.google.com/store/apps/details?id=com.bouncer)

Bouncer helps keep your apps in line by analysing and cutting pointless authorisations they don't require and preventing them from turning them back on. Prevent apps from accessing your camera and messages.



Firefox Focus

Free www.mozilla.org

If you aren't a fan of Google's relentless tracking of your mobile footprint, Firefox's privacy focused version is fast and comes complete with a bunch of great anti-ad and anti-tracking toggles.



Rootless Launcher

Free play.google.com

Rootless is a very lean, very clean, almost stock Android launcher that helps to speed up those devices bogged down by bloated manufacturer apps and skins.



Google Opinion Rewards

Free [google.com](https://play.google.com)

Opinion Rewards grants you Google Play credit for filling out very small, very basic surveys sent from Google to help refine its algorithms. It doesn't take long to earn a decent pile.



TickTick

Free ticktick.com

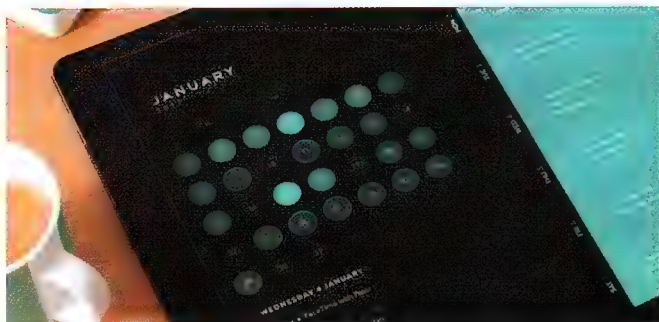
Hands down the simplest and cleanest To-Do app on Android, Tick Tick is a powerful but accessible way to organise your tasks, as well as syncing them on the cloud.



Spoiler Block

Free play.google.com

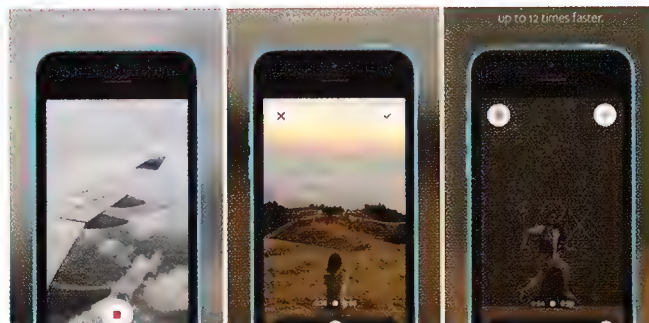
Sick of your friends on Twitter spoiling the newest Marvel blockbuster or Game of Thrones app? Spoilers Blocker removes those references from your feeds so you can tweet in (relative) peace.



Moleskin Timepage

Free moleskin.com/timepage

Timepage is an absolutely gorgeous and hyper functional calendar that interfaces with AI to give you tips around travel and weather to ensure you are always on time. Very clean and well designed.



Hyperlapse

Free [instagram.com](https://www.instagram.com)

Hyperlapse allows users with phones that don't feature image stabilisation to take long, beautiful timelapses, featuring both 10 and 30 second reductions as well as the ability to vary the speeds.



Halftone 2

\$4.49 www.juicybitssoftware.com

Think your dog, cat, or toddler deserves their own comic book? Halftone 2 allows you to create custom comics using your own photos and images. Fun, simple and easy to use.



Civilization VI for iPad

Free with IAP www.aspyr.com

Although it has a preview mode, *Civ VI* on iPad is one of the most expensive games on mobile, but also one of the most full featured. Leaves absolutely nothing behind, providing the complete PC experience with great touch controls.



Agenda

Free with IAP agenda.com

Agenda takes notes to a whole new level, automatically logging them by date and time, allowing different fonts, tags, lists and structures into projects and tasks.



iTranslate Converse

Free with IAP itranslate.com/converse

iTranslate allows real-time translation between 38 languages, simply by holding your iPhone up to the speaker and allowing them to speak freely. Works great in both loud and quiet environments.



Enlight Photofox

Free with IAP photofoxapp.com

PhotoFox is easily one of the most powerful photo editors on mobile, allowing for detailed layering, special effects and designs. Easy to use and mostly free to boot.



Focos

Free with IAP focos.me

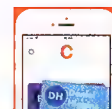
Focos takes advantage of iPhones with dual cameras alongside artificial processing to allow after the fact focus and lighting changes to your photos. Breaktastingly powerful.



Lake: Colouring Books

Free with IAP lakecoloring.com/

Sit back, relax and take some time to colour in beautiful, custom illustrations with up to five painting tools. One free per day or pay to get 60 drawings straight up.



Cinder

Free itunes.apple.com

Too many useless contacts in your phone? Cinder allows you to sweep them out of your list like a Tinder option – just swipe right to keep, left to delete.

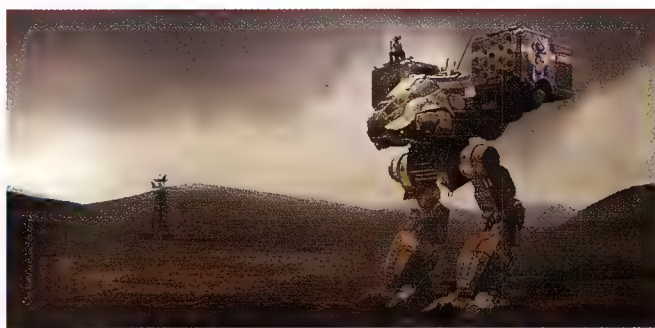
THE BEST PC EXCLUSIVE & INDIE GAMES



World of Warcraft: Battle for Azeroth

\$44.99 worldofwarcraft.com

We love that *WoW* flashes between serious and goofy. *Battle for Azeroth* embraces that tonal duality with conviction. The end result is a landscape full of moments that are sometimes bleak, sometimes hilarious, and always fun.



Battletech

US\$39.99 battletechgame.com

Harebrained Schemes has taken the hard sci-fi tabletop game (best known to PC players as the basis of the *MechWarrior* series) and married it to the *XCOM* formula in a way that brings out the best qualities of both.



Phantom Doctrine

US\$39.99 goodshepherd.games

Phantom Doctrine is a solid strategy game, but it manages to make a convincing case that we need more spy games that lean into the mechanics and meaning of espionage.



Total War Saga: Thrones of Britannia

US\$39.99 www.totalwar.com

A bold and surprising experience, but it's also a game that's often at odds with itself. It attempts to condense the *Total War* experience, throwing everyone into conflict and cranking up the pace. But, like many *Total War* games, still deeply compelling.



Frostpunk

US\$29.99
frostpunkgame.com

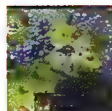
Who has time to take the temperature of the masses? I've got coal to mine. Get to it, my dear automaton. You might break down from time to time, but you'll never lose hope.



Objects in Space

US\$19.99
objectsgame.com

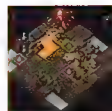
A game massive in scope, retro in style, and made by a small, independent Australian developer, *Objects in Space* puts you in command of a trading ship in a far away sector of space.



Northgard

US\$29.95 northgard.net

Northgard lives in the skirmish mode. The campaign mission design is good, but sometimes you just want to shake off the shackles and batter some Vikings in a sandbox.



Into the Breach

US\$14.99 subsetgames.com/itb.html

Into the Breach might lack a sense of mystery and expansiveness, but for me, it's more than enough to fuel a hundred hours or more of the most consistently rewarding tactics we've played in many years.



Exapunks

US\$15.99 zachtronics.com/exapunks

Exapunks shares with Zachtronics' previous game *Opus Magnum* the idea it's OK to brute-force a puzzle. You'll still unlock the next level and story snippet, but you won't make the leaderboards.



Frozen Synapse 2

US\$29.99
frozensynapse2.com

Frozen Synapse 2 is about running the very same simulations your opponent is probably running too and then trying to get inside their head.



Red Dead Redemption 2

\$99.95 rockstargames.com

The result of eight years hard graft by a handful of Rockstar studios, *Red Dead Redemption 2* offers an ornately populated reimagining of the wild west, and a Hollywood-aping narrative to boot. It's a bravely slow and meditative action game, rewarding patience and careful roleplaying.



Chasm

\$29.95 chasmgame.com

Chasm is a procedurally generated *Metroidvania* with beautiful pixel art and a grand sense of adventure. In development for five years, it's comfort food for anyone reared on 16-bit consoles in the 90s.



State of Decay 2

\$49.95 stateofdecay.com

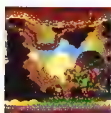
Most open world survival games have you punching trees for hours, but *State of Decay 2* takes a streamlined approach, opting for human drama instead of hunting and gathering. Three times bigger than its predecessor, it manages to breath life into zombie games – no small feat.



Call of Duty: Blackout

\$99.95 callofduty.com/blackops4

Call of Duty may no longer set the examples other shooters must follow, but it still has some neat tricks up its sleeves. There's no single-player in *BLOPS 4*, but the series' spin on the battle royale craze more than makes up for it – it's probably the best shooting experience you'll have this year.



Iconoclasts

\$29.95 www.konjak.org

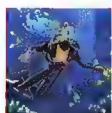
Developed by a single person – Joakim Sandberg – in eight years, *Iconoclasts* is an idiosyncratic, occasionally frustrating but always entertaining *Metroidvania* with a level of detail that raises the bar for everyone working in pixel art.



Assassin's Creed Odyssey

\$79 assassinscreed.ubisoft.com

Odyssey sheds so much of what *Assassin's Creed* is known for to fully embrace the core concepts of a roleplaying game – and it's all the better for it. The best *Assassin's Creed* to date.



Subnautica

US\$24.95 unknownworlds.com

I have spent nearly 50 hours on my current playthrough and my total playtime is over 120 hours. I am actually still playing. I have more than 2,000 screenshots of the beautiful world and its strange creatures. This game is GREAT.



Forza Horizon 4

\$79 forzamotorsport.net

What's here is beautiful, entertaining and polished, with vast amounts of driving and racing satisfaction to be had as you explore the stunningly rendered English countryside.



Shadow of the Tomb Raider

\$79 tombraider.square-enix-games.com

Shadow shows impressive restraint, rarely using combat as a crutch and focusing more on what makes this series special: namely, raiding tombs. And the tombs here are undoubtedly the star of the show.



Wreckfest

\$79 wreckfestgame.com

Wreckfest is a refreshingly different flavour of driving game. The spotlight's on physics simulation and damage modelling above all else here, every race a spectacle of exploding tire walls, mangled bonnets and nasty screeching sounds.



NBA 2K19

\$99.95 nba.2k.com

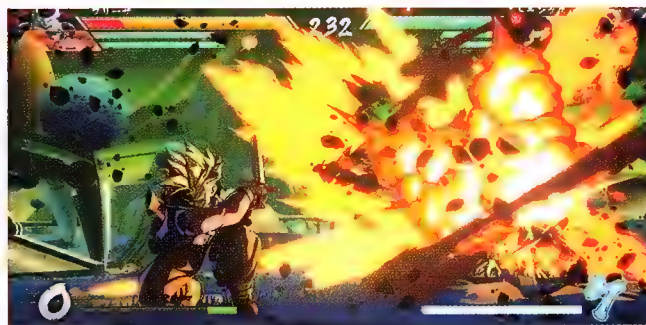
No basketball goes as hard in the paint as *NBA 2K19*, and this year's entry is one of the most impressive in the series to date. Featuring a refined shot meter system, new streetball moves and a new 3-on-3 Triple Threat Mode, *NBA 2K19* hits nothin' but net.



Ni no Kuni II: Revenant Kingdom

\$99.95 bandainamcoent.com

Studio Ghibli may not be involved this time around, however, *Ni no Kuni II: Revenant Kingdom* successfully captures the magic that made its predecessor such a delight. In fact, *Ni no Kuni II* is easily one of the best Japanese RPGs of the year.



Dragon Ball FighterZ

\$99.95 bandainamcoent.com

Perhaps the greatest *Dragon Ball Z* game ever made, *Dragon Ball FighterZ* looks and feels just like the classic animated series it's based on, with a satisfying combat system that's approachable to newcomers and deep enough to please fighter obsessives.



The Crew 2

\$99.95 thecrew-game.ubisoft.com

Bigger in scope and more polished in every way, *The Crew 2* improves on its predecessor by bringing stunt planes and speed boats into the mix, vastly opening up your traversal options in the process. Racing across the USA has never been so fun.



Project Cars 2

US\$59.95

projectcarsgame.com

Developer WMD has kept *Project Cars 2* going as something we keep coming back to thanks to a series of generous and great value DLC packs. We loved the *Ferrari Essentials* pack with its legendary cars.



Dead Cells

US\$24.99 dead-cells.com

Combining fast-paced combat, roguelike mechanics, *Metroidvania* progression and platforming and a healthy dose of procedural generation, this game ticks plenty of buzzword boxes.



Celeste

\$29.95 celestegame.com

The team behind *Towerfall* achieved something very unlikely with *Celeste* they made a tough-as-nails, twitch-oriented 2D platformer that's accessible to everyone, not just masochists. It's lushly drawn, charming, and unusually affecting.



Monster Hunter World

\$99.95

monsterhunterworld.com

The *Monster Hunter* series, long relegated to handheld consoles, is a bewildering prospect for anyone reluctant to crunch numbers in RPGs. *Monster Hunter World* is still an extraordinarily complex game.



Kingdom Come Deliverance

\$79.95 kingdomcomerpg.com

A realistic medieval RPG set in Bohemia, *Kingdom Come Deliverance* is a surprisingly polished effort, considering its ambition. Its sense of place is wonderful.



Onrush

\$99.95 codemasters.com/game/onrush

Onrush is one of the most exhilarating action games of the generation – just don't call it a racer. An objective-oriented multiplayer, um, car game, it was equal parts *Trackmania*, *Rocket League* and *Motorstorm*. Incredibly underrated.

System News

When is the latest and greatest too much too soon? Mark Williams contemplates the rise of frequent software updates.

Once upon a time, applying patches to your Windows operating system meant waiting for a service pack to come out. Big hulking installers that not only plugged security holes and fixed bugs, but also added new functionality and features. These typically took years to become available, making for systems that could be vulnerable to exploits for long periods of time.

When patching Windows via the internet became more popular it certainly sped up the frequency in which Microsoft could react to vulnerabilities and fix or add features. However, up until Windows 10, online update installation was always somewhat controllable by the end user. Sure, you could allow Windows to auto apply updates when they became available, but you could also choose if or when to install each individual patch manually as you decided, or you could simply turn off automatic updates and not run the update check.

Since Windows 10, that control has been taken away from the user. In most respects it's a good thing as this now forces Windows to update no matter what – which is great for handling users who don't care for running updates or aren't computer literate enough to know how – or are simply just too busy to remember. It also makes sure the whole user base for the most part is running with the latest patches installed, meaning everyone is reliably patched and up to date and are thus safer, and the ecosystem can react quicker to threats or issues, without much – if any – intervention needed from the user.

Where this goes wrong is when there's a bad patch. An update that simply breaks something. Anything from unexpected annoying behaviour right up to failing to boot into Windows or BSODs (Blue Screen Of Death).

Two very recent examples of this can

be found in the 1809 build of Windows 10 that rolled out to the public in September, only to be pulled shortly afterwards after reports of users having all their personal documents and files mysteriously missing after the update was applied; the other is a zip archive file extraction bug that doesn't overwrite files when the user asked them to be, potentially risking data loss if the user isn't careful.

Microsoft has pulled the 1809 update for now and at the time of writing it still hasn't been re-released.

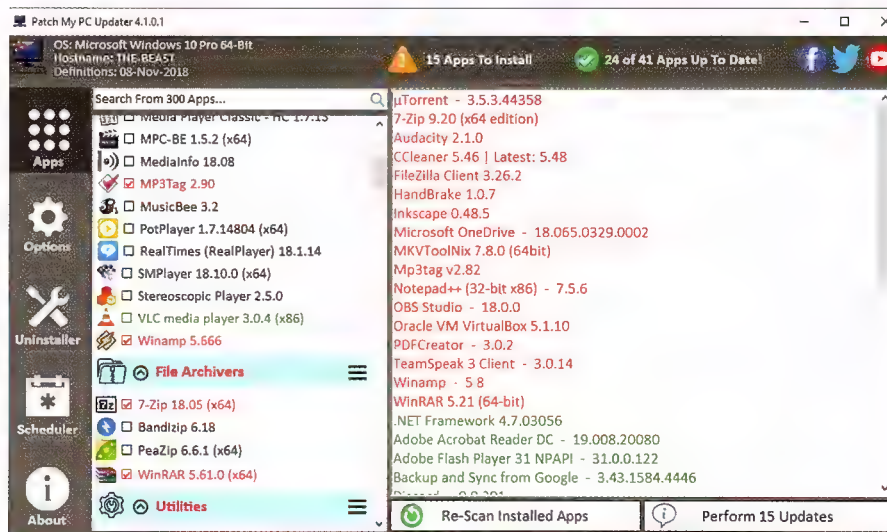
It's good that Microsoft can act quickly when necessary, pulling updates from getting distributed. And now that Windows 10 allows the user to have some minor control as to when the updates get applied, by delaying or scheduling them for later, it still leaves me a little uneasy that I don't have full control over what gets applied and what doesn't.

Something we do have more control over is the third-party applications that we install on our PCs. Some are good at keeping themselves updated automatically, such as web browsers, while others like to annoy you every time you start them up with varying degrees of user interactivity required thereafter to apply the update. Many don't even check at all.

A program I recently discovered has changed all that. Called Patch My PC (patchmypc.com/) the Home Updater version is free and handles updates for over 300 popular programs and growing. It checks for out of date applications you have installed and by clicking a single button it'll go and download and install all the program updates for you, no effort required.

I'm quite tech savvy, yet even I cannot keep up with the number of updates for things I have installed. On the first run this software found and updated fifteen programs!

Best of all you can even have it schedule itself to automatically run



SHOP TALK

What software do you pre-load onto your PC offerings?

Jaimie Ianson, Leader Computers:

"At Leader we install the latest stable version of Windows 10 but leave the systems reasonably free of bloatware otherwise. We are a named OEM Microsoft Partner, so we get access to all the new Windows builds, so we can generate images and test drivers ready for the release dates.

As we supply IT resellers and retailers, we leave off antivirus for our resellers to add on their preferred option. We do install the demo version of Microsoft Office, so the end user can just buy a key and activate, again so it's easy for our resellers to add on as needed."

John Zhang, TI Computers:

"We always use the latest available from Microsoft using the 'Windows 10 Media Creation Tool', sometimes afterwards some small updates are available from Microsoft, but the user can quickly download and install these themselves. If a customer purchases MS Office, then we will install that for them. We don't install any other software. Most customers want just a clean installation. But we can install software if requested."

and apply updates as frequently as you'd like without any further effort. You can also exclude any application from being updated, just in case, for example, you need a particular build that only works with a special plugin.

Do yourself a favour and check it out. It'll save you time and effort whilst keeping you fully patched and importantly, in control.

Market Watch

Mark Williams assesses a sampling of PC systems available this month.



Umart Pluto Ryzen3 1050 Ti Gaming PC 2018 V4

\$999 | TINYURL.COM/Y7BAEW5C

Fortnite, *CS:GO*, *Rocket League* and *League of Legends*. Are these but some of the games you're looking to play on a budget? Then this system is right up your alley.

Strictly for 1080p gaming, this system will provide a lot of fun for the money. The CPU is AMD's lowest Ryzen CPU on offer currently, but for undemanding games this quad core is more than enough to power the paired GTX 1050 Ti graphics card, which is nicely suited to these types of titles at 1080p resolutions.

The 8GB of system RAM is standard fare, but the nice touch is the 500GB SSD. Skipping a HDD all together to have the largest capacity SSD possible for the budget is really nice.

KEY SPECS: CPU: AMD Ryzen 3 2200G, Cooler: OEM, Motherboard: Asus Prime B450M-K, Graphics: Asus Phoenix GeForce GTX 1050 Ti 4GB GDDR5, Memory: Team Elite DDR4 2400MHz 8GB, Storage: Samsung 500GB SSD 860 EVO, Power Supply: 550W, Case: Casecom TZ-39 ATX



JW Computers GMR X5000-i792080Ti

\$4,999 | TINYURL.COM/YC5BVNX9

Looking for the best possible gaming PC available? This is it. While the CPU might not be Intel's highest end consumer i9 part, this octo-core CPU actually performs better for gaming in most benchmarks. The 16GB of RAM is perfect, too. Sure, 32GB is possible, but is largely unnecessary for gaming for the foreseeable future.

The graphics card is the best possible option available currently too. 4K, VR, multi-monitor; you name it this will run it. Storage has also been nicely selected. A big SSD for the OS, programs and some games, with a well-sized 3TB HDD for extra storage. This system is about as perfect as it gets without wasting money.

KEY SPECS: CPU: Intel Core i7-9700K, Cooler: Cooler Master MasterLiquid ML360R, Motherboard: Asus ROG STRIX Z390-F GAMING, Graphics: ASUS Dual RTX 2080 Ti Advanced Edition 11GB, Memory: Adata XPG 16GB DDR4 3000MHz RGB, Storage: ADATA 512GB XPG SX6000 SSD, Seagate 3TB BarraCuda HDD, Power Supply: Inwin 750W, Case: Inwin 307



PC Case Gear Omen 580 Gaming System

\$1,299 | TINYURL.COM/YCRZ7MV6

Looking for a great bang for your buck deal? Look no further. This system has a nice lower midrange feel to it. A six-core 12-thread processor is sufficient for any modern game and paired with a Radeon RX 580 means 1080p will be buttery smooth and even 1440p gaming will be quite a reasonable ask.

The 4GB on the graphics card is the main limiting factor for high resolution textures at 1440p and general performance at higher resolutions.

A nice SSD and HDD combo have mass storage well covered. And all housed in a chassis with internal lighting set to the ever popular red and black combination this'll look the part anywhere.

KEY SPECS: CPU: AMD Ryzen 5 2600, Cooler: OEM, Motherboard: Asus Prime B350M-A, Graphics: Asus Radeon RX 580 Dual Gaming OC 4GB, Memory: Team T-Force Dark 3000MHz 8GB DDR4, Storage: Kingston SSDNow A400 240GB SSD, Seagate Barracuda 1TB HDD, Power Supply: Be Quiet! Pure Power 10 500W, Case: Phanteks Eclipse P300

PLE Computers Home Ryzen APU Force

\$809 | TINYURL.COM/YCPJMMNW

AMD's APUs make for a solid option at the low end of the market. The Ryzen 5 2400G is a quad-core eight-thread CPU with what is essentially an RX 550 or GT 1030 already integrated, meaning gaming at 1080p should be possible in most games depending on graphical detail options chosen. Impressive for an integrated GPU!

While the processor is great for those on a budget, some other areas of this system are quite lacklustre. The primary two culprits

being system memory and mass storage. Running a system solely on a hard drive in 2018 is basically a sin these days. The capacity is nice, but the system responsiveness hit really isn't worth it. The 4GB of system RAM is bare minimum too for Windows 10 and anything but basic programs.

If you're eyeballing this system, the \$50 upgrade to the 480GB SSD option and \$74 option for 8GB total RAM would be money extremely well spent.

KEY SPECS: CPU: AMD Ryzen 5 2400G, Cooler: OEM, Motherboard: Asus Prime A320M-E, Graphics: Onboard (RX Vega 11), Memory: Geil 4GB Single DDR4 Pristine C16 2400MHz, Storage: WD Blue 1TB HDD, Power Supply: eVGA BV Series 450W, Case: Deepcool Tesseract Black/Red Mid Tower



PC blueprints

The APC team's picks for a part-by-part perfect PC build to suit your budget.



PARTS LIST

PART		PRICE
CASE	BITFENIX NOVA TG	\$75
PSU	450W CORSAIR CX450	\$69
MOBO	ASROCK AB320M-HDV	\$75
CPU	AMD RYZEN 3 1200	\$145
GPU	GIGABYTE GEFORCE GTX 1050 2GB	\$199
RAM	8GB (2 X 4GB) KINGSTON HYPERX 2666MHZ	\$129
SSD	120GB ADATA ULTIMATE SU650 2.5-INCH SSD NEW	\$59
HDD	1TB SEAGATE BARRACUDA ST1000DM010 HDD	\$65
OS	UBUNTU DESKTOP LINUX 18.04 LTS 64-BIT	\$0

APPROXIMATE PRICE: **\$816**

Last month we gave this machine a major shake-up, and it's performing well, so no need for any radical changes this month. In fact, there's only one change, and that's due to the Kingston SSD we used last month being difficult to find in shops. So instead, we've turned to Adata, and its SU650. Not exactly a performance offering, but it's incredibly affordable for a 120GB boot drive, and it's still faster than a traditional spinning drive. With only one hardware change, you'd expect the overall price to remain largely the same, but the new Adata SSD we've popped in here is \$21 more than the Kingston A400 120GB from last month, which pushes the overall cost just north of \$800. With second-gen Ryzen chips now doing the rounds, we are expecting a price drop on the AMD Ryzen 3 1200 any time now. At the time of writing it's holding steady at the same \$145 it was last month, but keep an eye out, it's still a great low-cost CPU, and well worth being the basis of a budget system.



PARTS LIST

PART		PRICE
CASE	FRACTAL DESIGN MESHIFY C	\$129
PSU	550W EVGA SUPERNOVA 550 G3 80+ GOLD	\$149
MOBO	ASUS ROG STRIX B450-F GAMING	\$209
CPU	AMD RYZEN 7 2700	\$379
COOLER	CORSAIR HYDRO H100I PRO 240MM RGB AIO	\$160
GPU	MSI GEFORCE GTX 1070 TI GAMING NEW	\$649
RAM	16GB (2 X 8GB) G.SKILL RIPJAWSX 2133MHZ	\$219
SSD	250GB SAMSUNG 970 EVO M.2 PCIE SSD	\$138
HDD	1TB SEAGATE BARRACUDA ST1000DM010 HDD	\$65
OS	WINDOWS 10 HOME 64-BIT OEM	\$140

APPROXIMATE PRICE: **\$1,395**

The specification for our mid-range machine has remained stable this issue as well, with the only change being the graphics card, as we found the MSI card for \$10 less than the Zotac we used last issue. At the time of writing, the GeForce RTX 2070 is imminent, but we're not sure how it'll perform in ray tracing and DLSS titles, so we will hold fire on recommending it for now. Of all the RTX cards, this is the one that has the most sensible pricing, so it's worth watching this space. As with our budget build, there's little else that has seen a price drop over last month's system, and once again, it's the AMD processor that we expect to soon see fall in price. The Ryzen 7 2700 is a second-generation Ryzen CPU, though, so that price drop may just be AMD trying to spoil the launch of Intel's 9000-series chips. It will be interesting to see whether the Core i5-9600 can throw a monkey wrench in AMD's plans next issue.



UPGRADE OF THE MONTH

Corsair HS70 SE Wireless

\$159, WWW.CORSAIR.COM

We're happy with all these builds at the moment, and think they hang together well enough that we don't need to highlight individual components in this "Upgrade of the Month" slot. Which is why we've elected to focus on a peripheral instead.

Of all the headsets we've seen recently, these wireless cans from Corsair really impress. We have many fears with wireless headsets – sound quality and battery life are particularly sensitive areas – but the HS70s allay them impressively. The soundstage is crisp and balanced, with a distinct lack of the overbearing bass that is common in so-called gaming headsets. There's the added bonus that these look the part, too, with no silly LEDs draining the battery.

On top of all that, they're not stupidly priced, as wireless headsets used to be. Whatever system you're building, do yourself a favor, and grab a good set of cans while you're at it.

"You could save a little going with a cheaper case, provided you choose something that fits in a 240mm AIO cooler – which will be almost anything on the market."

The 2950X in this "Turbo" build represents impressive value for money, so we see no need to swap it out yet. If you're looking for serious multithreaded performance, you're going to be pushed to come up with anything that can beat the 16-core, 32-threaded monster we have here. We did list the price incorrectly last month, though; apologies for that.

As ever, there are bargains to be had on processor, motherboard, and RAM bundles, which are worth checking out at the time of purchase. You could save a little going with a cheaper case, provided you choose something that fits in a 240mm AIO cooler – which will be almost anything on the market.

The big change here is the inclusion of the GeForce RTX 2080, which costs considerably more than the GTX 1080 Ti we had last month, and is something of a contentious addition, even in the office. The team is split evenly between sticking with the 1080 Ti for now, and saving a big chunk of cash, and those backing the potential of what RTX may bring. Ultimately, it's your call. We're listing the Gigabyte Gaming OC card here because it's the cheapest we could find that still has respectable cooling. Asus offer an RTX 2080 Turbo for the same price, but it uses a cooler that's very similar to the last gen reference card and only has a single fan, so the Gigabyte gets the nod this issue.

PARTS LIST

PART		PRICE
CASE	NZXT H700i	\$173
PSU	CORSAIR RM750X MODULAR GOLD	\$110
MOBO	ASUS PRIME X399-A	\$300
CPU	AMD THREADRIPPER 2950X	\$1,415
COOLER	ENERMAX LIQTECH TR4 II 240MM RGB	\$140
GPU	GIGABYTE GEFORCE RTX 2080 GAMING OC NEW	\$1,299
RAM	32GB (4X 8GB) G.SKILL TRIDENTZ 3200	\$316
SSD	512GB SAMSUNG 970 PRO M.2 NVME	\$200
HDD	2 X 2TB SEAGATE BARRACUDA ST2000DM006	\$120
OS	WINDOWS 10 HOME 64-BIT OEM	\$100
APPROXIMATE PRICE:		\$4,173



Tracing the rays of the future

Nvidia's RTX graphics cards may be ahead of their time, but what sort of rig can you build with one now?

On the surface, this should be a fairly straightforward "Build It." The remit is simple enough: Piece together a reasonable home for Nvidia's latest and greatest graphics card, the GeForce RTX 2080 Ti. Having said that, the word "reasonable" takes on a slightly different angle when said graphics card is going to set you back over \$2,000. Plus, there's the added fun that we don't know for sure which processor is going to give this new silicon the necessary room to strut its stuff, because we're in unknown territory when it comes to ray tracing. Do we want more cores, faster single-core performance, or some hitherto unknown combination of the two?

We briefly toyed with the idea of pairing this new graphics card with Intel's even newer Core i9-9900K. We backed out of that idea, though, as we felt that we'd be treading on the toes

of the forthcoming Dream Machine (while we haven't made the final decision on the CPU for that build yet, the Core i9-9900K is in the running). The other reason we didn't want to build with the new Intel CPU is that building with two completely new pieces of gear is just asking for trouble — much better to go with something that you know for certain just works.

So, the star of the show here is the graphics card, pure and simple. And while we don't entirely know how everything is going to shape up for the future of hybrid rendering, we do need to give that card room to breathe. That means plenty of RAM and storage, and all ensconced in the kind of case that shows off your new super-expensive polygon-pushing pride and joy.

FUTURE-PROOFING

We can't escape the fact that the GeForce RTX 2080 Ti is really expensive. We've opted for a third-party offering, with the overclocked, triple-cooler card from Asus providing the reason for this machine's existence. To make sure it's kept fed with data, the rest of the build is pricey as well. To be fair, though, you wouldn't want to slide a \$2,079 graphics card into a bargain-basement budget rig.

For the heavy lifting, we've turned to Intel's current top-end CPU, the Core i7-8086K. At least, it was top-end until Intel released its new processors as we were writing this, but as the 9000-series family hasn't been fully unleashed yet, we'll stick with what we know is a strong gaming processor. Capable of turboing up to 5GHz on more thread-shy titles, and offering six physical cores (that's 12 threads, thanks to Hyper-Threading) to more modern titles, this processor can handle the most cutting-edge of games with ease.

Processor and graphics card sorted, the next big decision is what motherboard to use, and here we've elected to use the Asus ROG Maximus X Formula to provide the backbone for the machine. This is a top-end board, with plenty of quality features, including decent audio, integrated Wi-Fi, and RGB Armor to keep the build looking sleek, as well as colorful. The solid steel backplate means there's no flexing when you're building, either.

32GB of RAM and a 1TB M.2 SSD mean that we're not hanging around waiting for our next game to load, and also ensure that we have a speedy experience in Windows and more serious titles as well. Finishing off

PARTS LIST

PART		STREET PRICE
CASE	CORSAIR OBSIDIAN SERIES 500D	\$189
MOTHERBOARD	ASUS ROG MAXIMUS X FORMULA	\$629
CPU	INTEL CORE I7-8086K	\$669
CPU COOLER	RAIJINTEK ORCUS 240	\$149
GPU	ASUS STRIX GEFORCE RTX 2080 TI OC	\$2,079
MEMORY	32GB (4X 8GB) HYPERX PREDATOR DDR4 @ 2,933MHZ	\$599
PSU	BE QUIET! STRAIGHT POWER 11 850W	\$239
STORAGE	SAMSUNG 970 EVO 1TB M.2 SSD	\$429
OS	WINDOWS 10 64-BIT OEM	\$145
TOTAL		\$5,127

the specification, we have a Raijintek Orcus 240 AIO cooler that we've been keen to try for a while, a quality Be Quiet! 850W PSU, and for the case we've turned to the Corsair Obsidian 500D, which is a striking-looking chassis for any high-end build. Oh, and don't forget a copy of Windows 10 while you're at it.



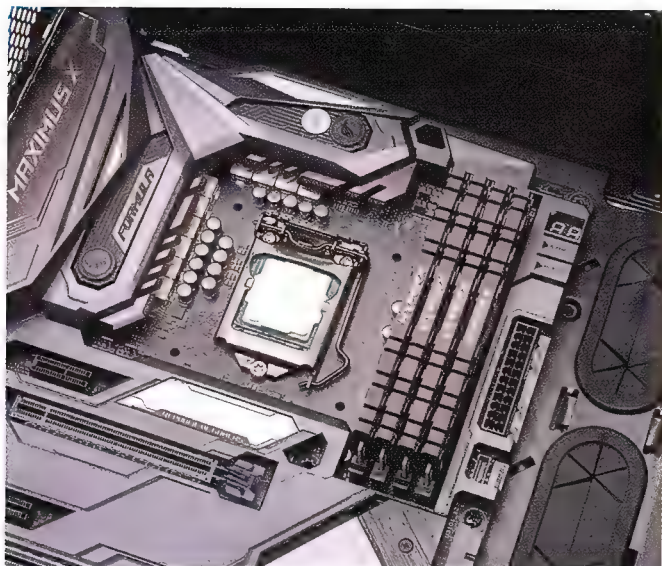
1 STRIPPED DOWN

We love starting a build by stripping the case down to the absolute minimum, and that's exactly how we got the ball rolling here, although in this instance, there isn't a lot to remove. The Corsair Obsidian Series 500D is an open design, and easy to work in from the get-go. Popping off the doors is simple, and doesn't require any tools, because they're held in place with a magnetic strip. Simply swing them open and lift them off the hinges, and you've got easy access to everything. Spinning the machine around, the only obvious thing to temporarily remove is the cable cover, which again is simple to do. The drive cages on the rear can be popped out too (thumbscrews abound), and you can ease out the dust filters as well (which are held in place magnetically), although you don't need to do so to start building.



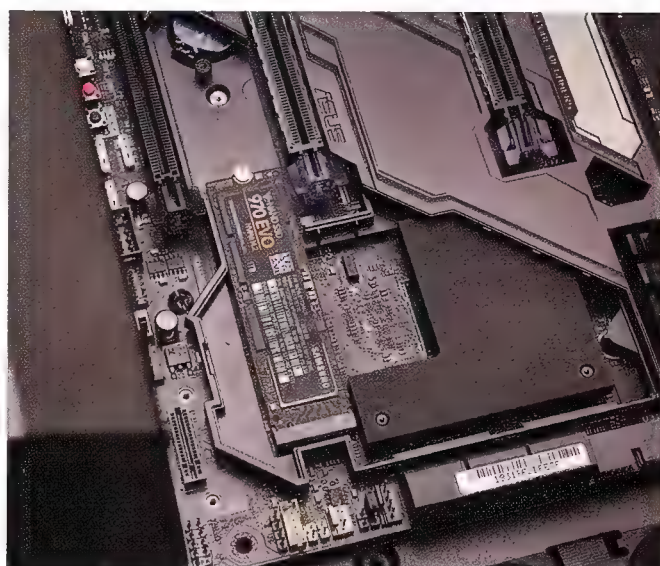
2 STANDING OFF

Time to build. The Asus ROG Maximus X Formula is a solid, heavy motherboard, but easing it into the awaiting space instantly threw up an issue – it wouldn't lay flat, due to a location peg in the center of the motherboard. We sometimes see these used to help out during installation, but here we found it slightly misaligned, forcing us to remove it. Once done, it was still a tight squeeze getting the motherboard into place, in part because it boasts an integrated I/O plate. That and the fact that there isn't much clearance at the bottom of the case, due to the PSU cover. There is a trend for I/O plates to be used on high-end motherboards, but it's worth knowing that they can be tricky to install, even in more open cases, like this one.



3 CORE COMPONENTS

With the motherboard in place, we can now start installing components. Normally, we would install the CPU outside of the case, just because it can be a little tight, but there really is so much space inside the Obsidian 500D, that this wasn't an issue. In fact, we had more trouble with the motherboard's Armor than we did the case, although this was more of a problem when it came to installing the cooler, but we'll come back to that later. The RAM was the next thing to install, and sliding all four sticks into place is as pleasing as it is capacious. Again, there's plenty of room to do so – the fact that there's no front drive cage helps here.



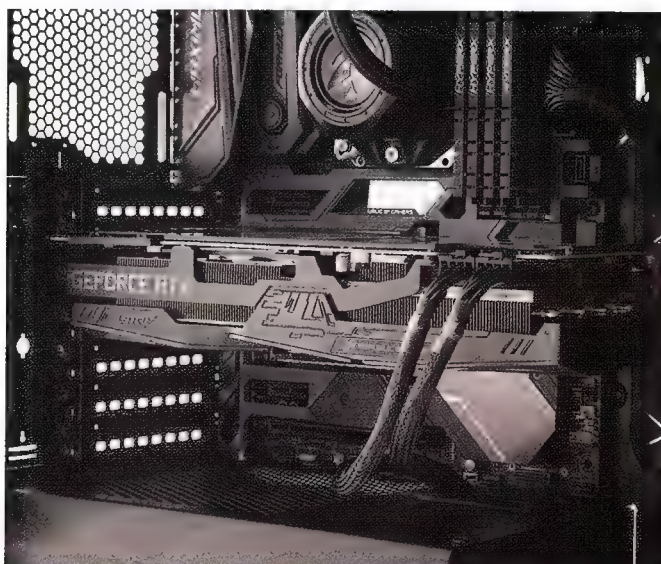
4 COOL DRIVING

M.2 SSDs can get hot under load, so it's a good idea to have a decent heat spreader present. The one you'll find on the Maximus X Formula is particularly huge, and you'll find it as part of the large ROG eye logo, toward the bottom-right of the motherboard. Releasing the three screws on this plate enables you to remove it and reveal the M.2 connector. We were momentarily thrown by the fact that the retention screw for the drive wasn't preinstalled, but actually in the motherboard box – it took longer than it should have for us realize this. Once found, though, securing the 1TB Samsung 970 Evo SSD was easy, and that huge cooler means that it shouldn't be throttling anytime soon. It's worth noting that it isn't easy to access this drive once your graphics card is installed, but this is often the case with the location of M.2 connectors.



5 THERMAL CONSIDERATIONS

It's at this point in the build where things can get tricky, and sure enough, installing the cooler had us wishing that we had a spare hand. It's actually a great system once everything is set up, because the cooler is held in place by just two screws, but getting to that stage isn't easy. You have to hold the backplate in place on the rear of the motherboard while screwing another plate into place on the processor side – long arms are essential; a spare hand or two useful. We elected to place the radiator in the front of the case, to keep things clear at the top, but an argument could be made for roof-mounting instead. It's worth noting that the pump isn't integrated into the CPU block, so ensure you plug this and the various fan cables into your motherboard.



6 TRACING RAYS

It's time for the star of the show, the Asus Strix GeForce RTX 2080 Ti OC, to get eased into position. After removing the two blanking plates, this is straightforward, although care is needed because this is a heavy card, and you don't want to drop it on to your motherboard. If you get a PCIe extension cable, this case does support vertical mounting of your graphics card, which would look great against the side panel's smoked glass, but these things aren't cheap, and we've already dropped a big chunk of cash on this machine. Still, it's an option. At this point, we installed the power supply, and discreetly threaded the various cables through to where they were needed. The top eight-pin EPS connector can often be tricky, but we had cable to spare here.



1 The Raijintek Orcus 240 is an impressive cooler, with a healthy array of lighting options, and it even comes with a remote control.

2 The star of the show is the RTX 2080 Ti, which is a beast of a card, taking up plenty of room, even in this large case.

3 The power supply shroud does a good job of keeping the build clean, with all the major cabling hidden in the rear.

Gamer's delight

There were no nasty surprises putting this machine together, other than the final price—although we feared this was always going to be the case with Nvidia's latest and greatest GPU. You could easily spend a whole lot more, and the core performance wouldn't change too much, while spending less could well throw a monkey wrench in the works. This isn't a budget build by any stretch, but it is probably the most affordable way of building an RTX 2080 Ti machine that isn't held back by the processor or storage.

The trickiest part of the build involved the cooler, and we could have

mitigated this by installing the bracket outside of the case, simply because holding the backplate in place would have been easier (and wouldn't have required quite so many hands). We could have gone for a 360mm radiator in the front as well, which would have improved airflow further, although we didn't have a problem with heat in this machine anyway. The fact that you can control the lighting of the cooler using the tiny remote was a bit of a bonus, though, and it can look pretty if you care about such things.

The goal of this build was to piece

together a cutting-edge gaming machine that will survive the ravages of time, and give the RTX 2080 Ti the best possible future. We feel we hit this brief pretty convincingly, and the benchmarks would seem to back that up, with some impressive results when compared to our zero-point machine. The *Total War: Warhammer II* result, which rolled in 120 percent better than our zero-point, shows the kind of improvement that is possible with this new graphics card, although this is over the older GTX 1080.

At this point, we're still not sure how the RTX 2080 Ti performs in real-time ray-tracing titles or DLSS, but we'll revisit the performance at these tasks in a future issue, possibly with this build (if we haven't stripped it down by then). For now, this certainly makes for a smooth gaming experience, and returning to a normal gaming machine after using this on a 4K screen makes for an uncomfortable experience.

We like to ask ourselves what we'd change at the end of every build. Here, we're not sure that anything stands out. The case is a delight to work in, and looks great when all the cabling is tucked out of sight. We are tempted to try mounting the graphics card vertically, and this could be the chassis that pushes us over the edge to try it, especially if we use a graphics card that lights up as much as the rest of this system. ■

BENCHMARK RESULTS

	APC LABS TEST PC	THIS SYSTEM
CINEBENCH R15 MULTI (INDEX)	959	1,399 (46%)
CRYSTALDISK QD32 SEQUENTIAL READ (MB/S)	3,422	3,512 (3%)
CRYSTALDISK QD32 SEQUENTIAL WRITE (MB/S)	1,706	2,510 (47%)
RISE OF THE TOMB RAIDER (FPS)	93	154 (66%)
TOTAL WAR: WARHAMMER II (FPS)	55	121 (120%)
TOM CLANCY'S GHOST RECON WILDLANDS (AVG FPS)	48	83 (73%)
3DMARK: FIRE STRIKE EXTREME (INDEX)	9,128	15,611 (71%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of an Intel Core i5-8400, 16GB of Corsair Vengeance LPX @ 2666, an MSI GeForce GTX 1080 Armor, and a 500GB 960 Evo M.2 PCIe SSD. All tests were performed at 1440p at the highest graphical profile.

howto

» QUICK TIPS

Experts solve your computing problems

APC and its readers can be one giant helpdesk. If you have a technical problem, chances are one of us can solve it.

SECURITY

WHAT'S ADAWARE'S WEB COMPANION?

I've suddenly become aware of an icon in my Taskbar notification area – clicking it brings up a screen pointing to Adaware Web Companion, with some kind of security tool for my web browser. What is this, and is it safe?

Stuart Fenton

This almost certainly got on to your computer alongside another program – in other words, a Potentially Unwanted Program or PUP. The first warning can be found on the program's own FAQ, with "How do I uninstall Web Companion from my computer" the second article in the list. Click Start > Settings > Apps and scroll down until you find and entry for Web Companion near the bottom of the list – you'll see when it was installed, giving you an idea of how it arrived on your computer (sort the program list by 'Installation date'). More importantly, you'll be able to remove it. Click 'Yes, I'll take the chance' when prompted (the scaremongering is another indicator that this program isn't necessarily to be trusted). It does leave some leftovers, so if you want a more thorough clean-up, remove it using IObit Uninstaller Free (www.iobit.com).

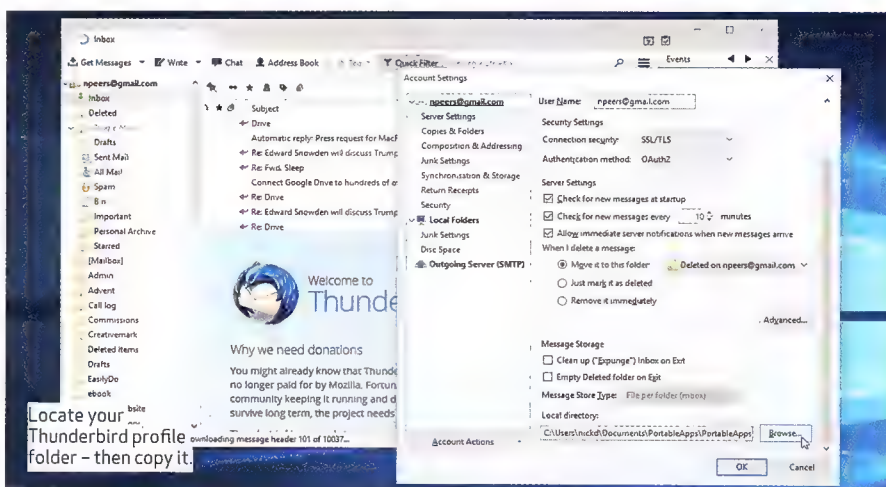
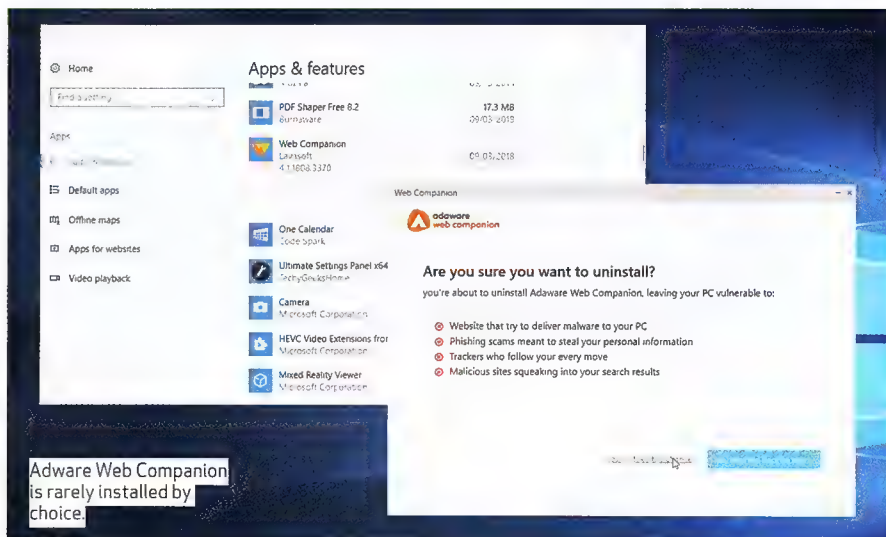
Matt Hanson

LINUX

LOW-ENERGY COMPUTING

I am trying to find a low-energy solution for a good performance machine I can use for my weather satellite monitoring and my weather stations. My machines run 24/7, so I am trying to reduce the number of watts I use, and hence my electricity bill. I have been a Gentoo enthusiast since probably 1999. My present machine runs CentOS 7, with Intel Core 2 Quad CPU Q6600 2.40GHz, it has 16GB of memory and two NICs bonded, because I need plenty of Ethernet speed for moving the weather satellite images around. It has two 500GB drives with RAID 1 and one 1TB without. The VGA is Nvidia Corporation GT200 GeForce GTX 260 dual-head for two monitors. Yup, lots of real estate, so quite a bit of power needed. Is there any advice you can give me?

Francis West



Yikes! That old Q6600 in itself will consume lots of power – its TDP is 105W. A modern desktop processor will likely halve this (taking into account lower-power DDR4 and motherboard chipset) and provide triple the CPU power, combined with integrated graphics able to run three displays and a motherboard with dual NICs. The six-core AMD Ryzen 5 1600 is a good all-round choice – but you will need a graphics card on top – to build from scratch. On the Intel side, for similar speed, you'd want a Core i7 7700K, but it's almost \$200 more just for the chip, though it does have integrated graphics. Do let us know how you got on!

APC Team

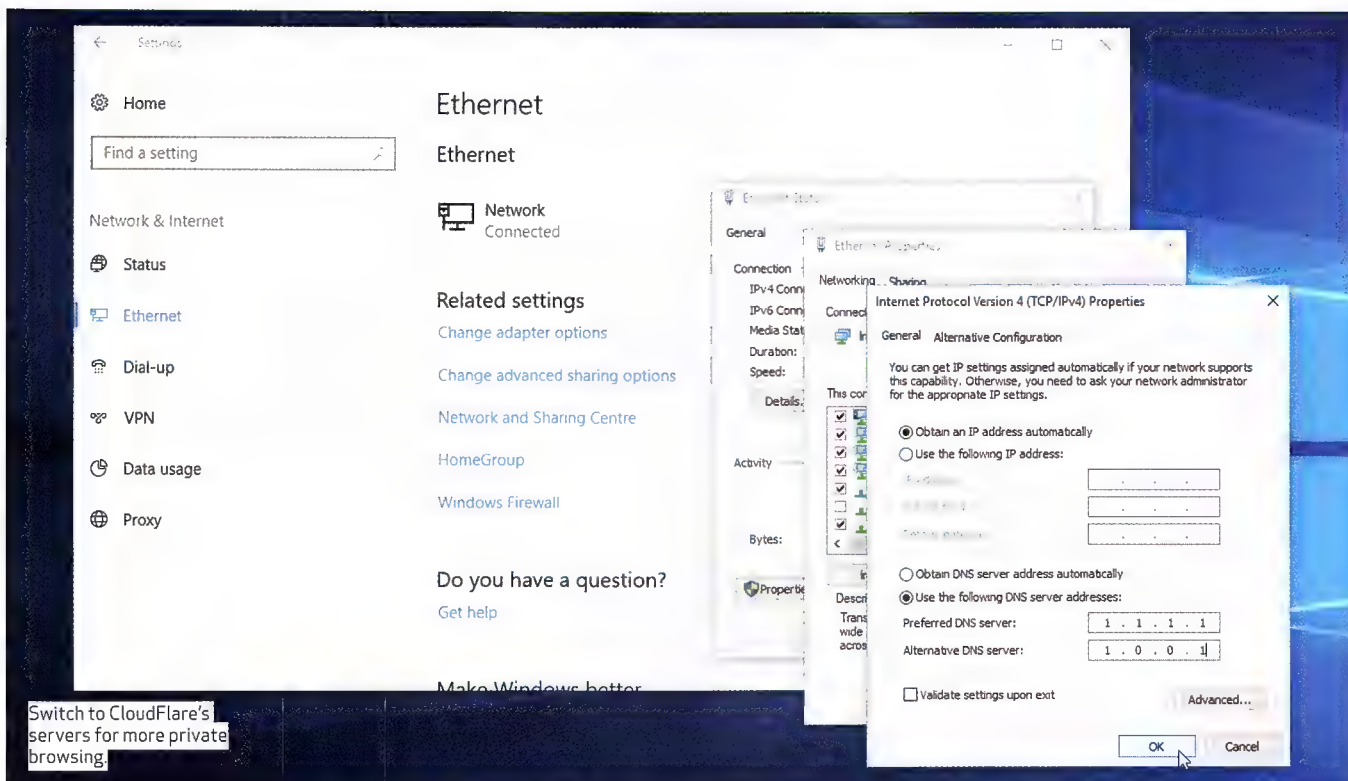
EMAIL

SWITCH FROM THUNDERBIRD TO THUNDERBIRD PORTABLE

I've decided to switch from an installed copy of Thunderbird to a portable one, so I can carry it around with me. I'm trying to copy my profile – which I presume contains everything I need – from the installed copy to my portable copy, but am confused by the instructions online. Can you help?

Steve Cox

By default, Thunderbird stores all your data and settings in a profile folder under C:\Users\[Username]\AppData\Roaming\Thunderbird\Profiles\ - the quickest way to open this folder is to



press Windows-R, then type %AppData%\Thunderbird\Profiles\ and press [Enter]. Look for a folder with 'default' at its end – this is your profile folder.

Open up Thunderbird Portable, but skip the account configuration and close the program – then navigate to ThunderbirdPortable\Data where a new 'profile' folder has been created. You need to copy the contents inside the 'default' folder into this folder, replacing any items when prompted.

Reopen Thunderbird Portable again – you should find everything has been migrated across, enabling you to uninstall the other version and use Thunderbird Portable going forward. Note, your original profile folder will be left behind – either delete it manually, or uninstall it using IObit Uninstaller (<http://bit.ly/2HtDmL6>), which can remove the profile folder automatically for you as part of its leftover cleaning feature.

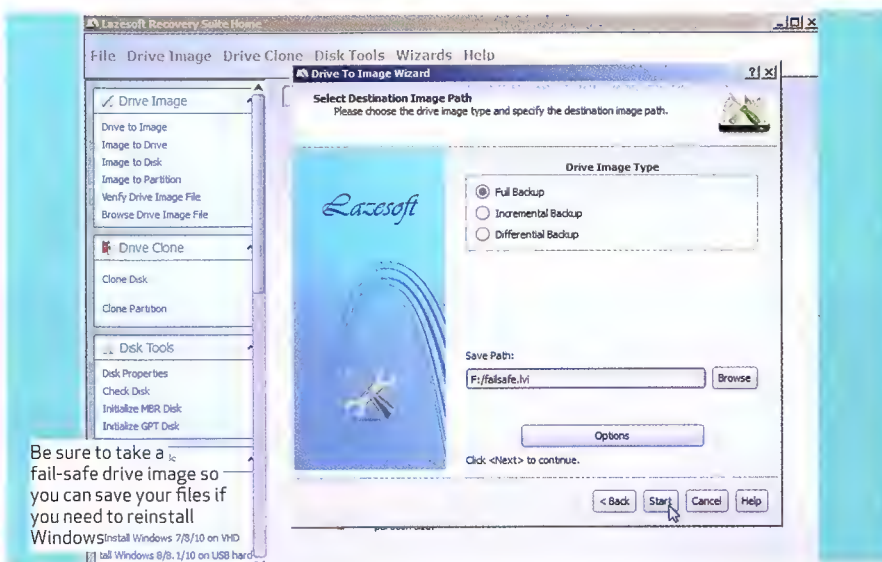
Rob Mead-Green

INTERNET WHICH DNS PROVIDER SHOULD I CHOOSE?

I've been reading up on DNS servers and wonder if you have any pointers as to which one I should choose.

Rav Saluja

DNS servers are used to translate user-friendly web addresses like techradar.com into their corresponding public IP address (185.113.25.59 in TechRadar's case). By default, you're using your own Internet provider's DNS provider, but this comes with certain privacy



concerns since by default your browser history isn't encrypted and can be logged.

ISP-provided DNS servers aren't always the quickest either, but the good news is there are a number of third-party alternatives you can try – these DNS server addresses can be added to individual devices on your network or applied at the router level to apply to all your networked devices.

In the past we've been fans of OpenDNS.com (DNS servers: 208.67.222.222 and 208.67.220.220), but we're currently trialling CloudFlare's new free offering (DNS servers: 1.1.1.1 and 1.0.0.1), which promises to be both private and fast. Visit <http://1.1.1.1> where you'll find details of what it promises to do and – crucially – how to

apply it to either individual devices or your entire network.

Matt Hanson

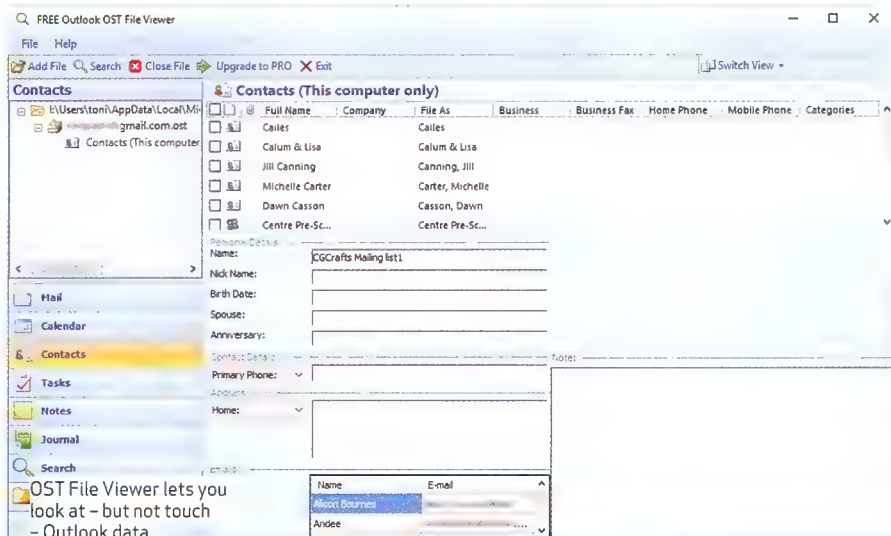
WINDOWS WINDOWS 7 PC BOOT ERROR

My PC will no longer boot – it shows me the following error: 'Your PC/Device needs to be repaired' followed by one of two errors. Both ask for recovery tools. What should I do?

Jamie Thomas

Try running Windows 7's automatic repair tool from the Windows 7 installation disc. If this doesn't work, try a third-party repair disc instead. Our personal favourite is Lazesoft Recovery Suite Home (www.lazesoft.com/download.html).

Download and install Lazesoft's



Home Edition from on a working PC. Choose the 'Burn CD/USB Disk' option and then follow the prompts to create a Windows 7 rescue disc or flash drive. Start up your afflicted PC with this disk inserted.

If your files are stored on the same partition as Windows and you've not backed them up, connect an external

drive, then select Data Recovery followed by Fast Scan. Browse and select the files or folders you want, then click Save Files to transfer them.

If the drive isn't damaged, taking a fail-safe drive image ensures that none of your files are lost if you're forced to reinstall Windows. Choose 'Disk Image & Clone', select the 'Backup (Drive to

Image)' option and follow the prompts to save your image.

Now select Windows Repairs to access Lazesoft's comprehensive selection of repair tools. Start with the 'One Click Fix Crash Solution' that has built-in undo.

Nick Peers

RECOVERY

RECOVER OST FILE

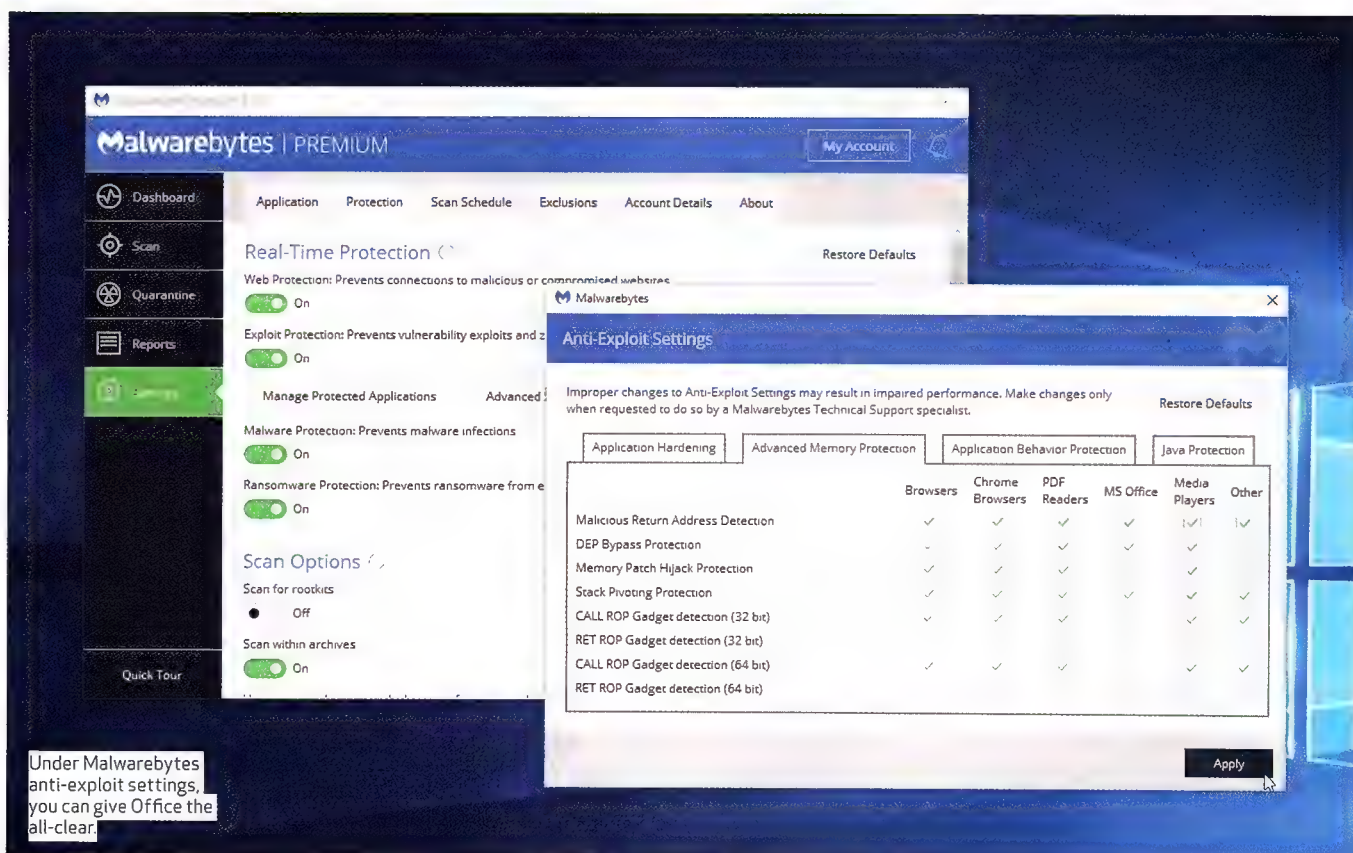
After a recent crash, I was forced to reinstall Windows. Despite having backed up my Outlook OST data file, I'm unable to load it back into Outlook. I've got loads of contacts stored on that file - how can I get them back?

Frances Taylor

OST files are Offline Storage Files, which are used when you connect to your email provider using IMAP to preserve a copy of the original emails on your mail server. Unlike PST files, these can't be added back to Outlook - the logic is that you'll simply re-sync Outlook with your mail server and all will be fine, but it fails to account for the fact that other data - such as Contacts - are stored in the OST file. You can open the OST file and browse the data inside it using free OST viewer tools - one of the best is Free Outlook OST File Viewer (www.freeviewer.org), which can view contact lists as well as individual contacts. From here you can manually copy the data out.

Cat Ellis ■

"You can tweak Malwarebytes to ignore the kind of specific threat that it mistakenly thinks Office Tab represents."



Under Malwarebytes anti-exploit settings, you can give Office Tab the all-clear.

Manage your media in Kodi

Use this powerful and free media player to manage and play your entire music, movie and TV show collection.

Kodi is an extremely versatile open source application. It offers a very elegant way to manage all your TV shows, films and music in one place. Each aspect of Kodi can be changed from its themes (known as 'skins') to the addition of various plug-ins, which support extra features such as YouTube playback.

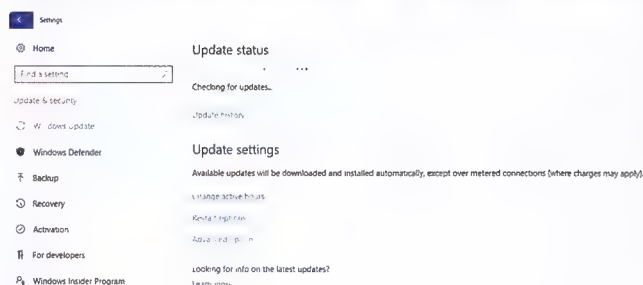
One particularly useful feature concerns Kodi's video and audio scrapers. These scour the Internet to match your media files to a particular movie, TV programme or song. The resulting metadata is displayed in the app.

The aim of the Kodi project is to turn your PC into a home media centre. To this end, the application also supports

a number of remote controls, including official touchscreen apps for mobiles and even game controllers. Point your web browser at tinyurl.com/apc462-kodi for a full list of compatible devices.

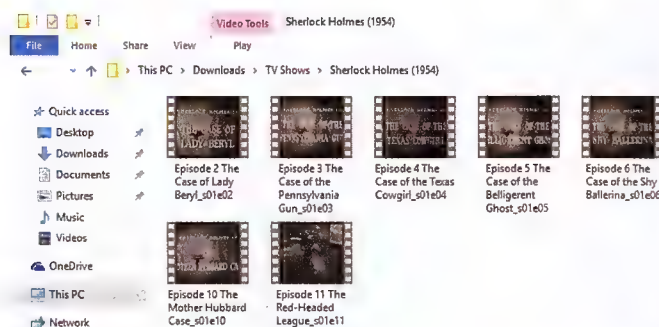
Now join us as we show you how to set up and use Kodi on your PC.

Get started with Kodi media player



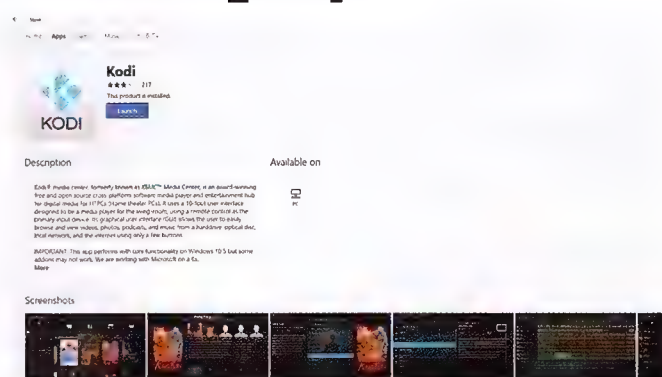
1 UPDATE WINDOWS

Kodi will only work with the latest version of Windows 10. You can check if your system is up to date by heading to Settings > 'Update & security' > Windows Update. Save and back up any files that you're currently working on, then click on 'Check for updates'. If your PC needs to reboot, let it do so, since you won't be able to install Kodi until the update is complete.



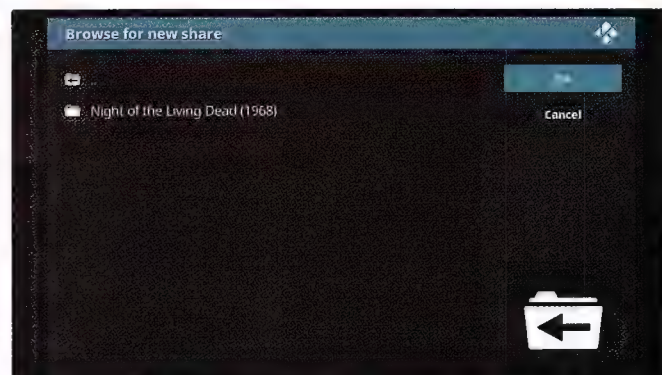
2 RENAME YOUR MEDIA

If you want Kodi to recognise your movies and TV shows, you need to name them correctly. Open File Explorer and head to your video collection. Rename films using 'Name (Year)' - 'Night of the Living Dead (1968)', for example. Rename TV shows using 'Name_sXeY' - 'Adventures of Superman_s01e03', for example, then place them inside a folder with the name of the TV series.



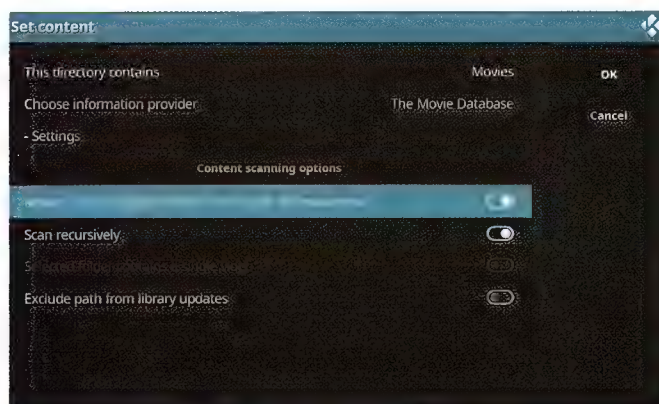
3 DOWNLOAD KODI

Fetch the latest stable version of Kodi by opening the Microsoft Store and typing 'Kodi' into the search bar. Click 'Get'. If you want the most up-to-date version of Kodi, open your browser and navigate to <https://kodi.tv/download>. Click 'Windows' under 'Choose your weapon', then Nightly Build. When you first launch Kodi, Windows' Firewall will display an alert. Click 'Allow Access'.



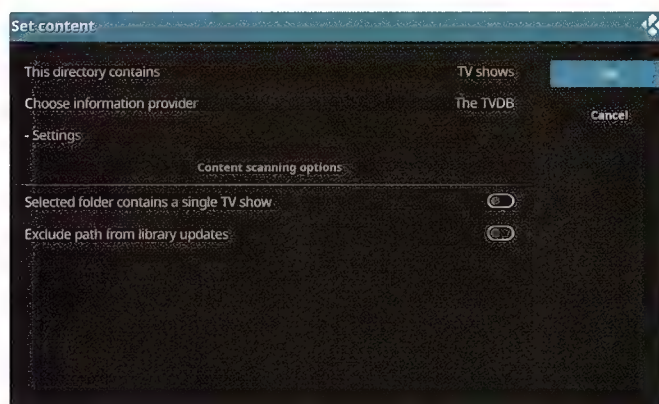
4 ADD MOVIES

Click on your Start menu and then on Kodi under Recently Added. Kodi will now launch in full-screen mode. Use your mouse or the arrow and [Enter] keys to navigate and choose options. First hover over Movies then on Add Videos. The 'Add Video Source' window will open. Click on Browse and navigate to the folder where you keep your movie collection, then click OK.



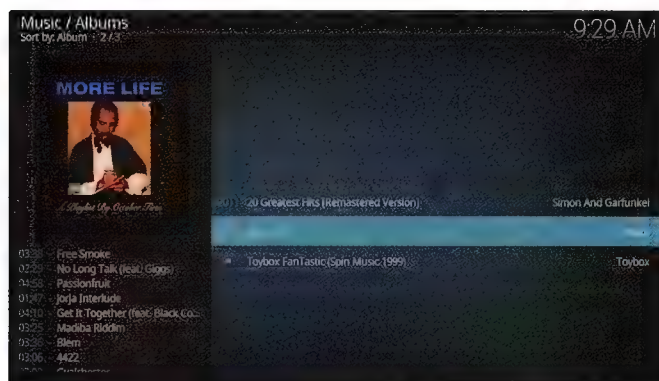
5 DEFINE CONTENT

Once you've set the video folder, the Set Content window appears. Click on the word 'none' beside 'This directory contains'. You can now specify that this folder contains Movies. By default, information about films is taken from The Movie Database. Under 'Content Scanning Options', you can specify whether the movies are in individual folders or not. Finally, click OK.



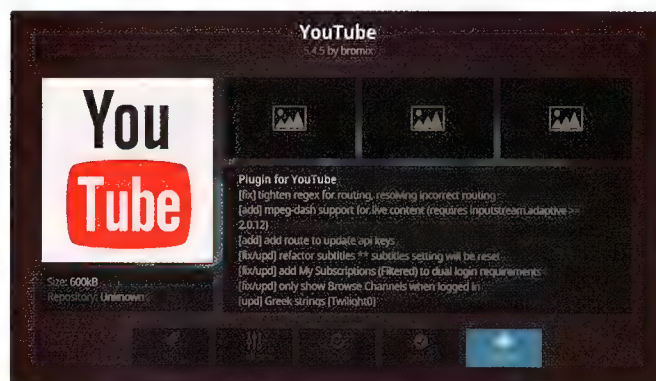
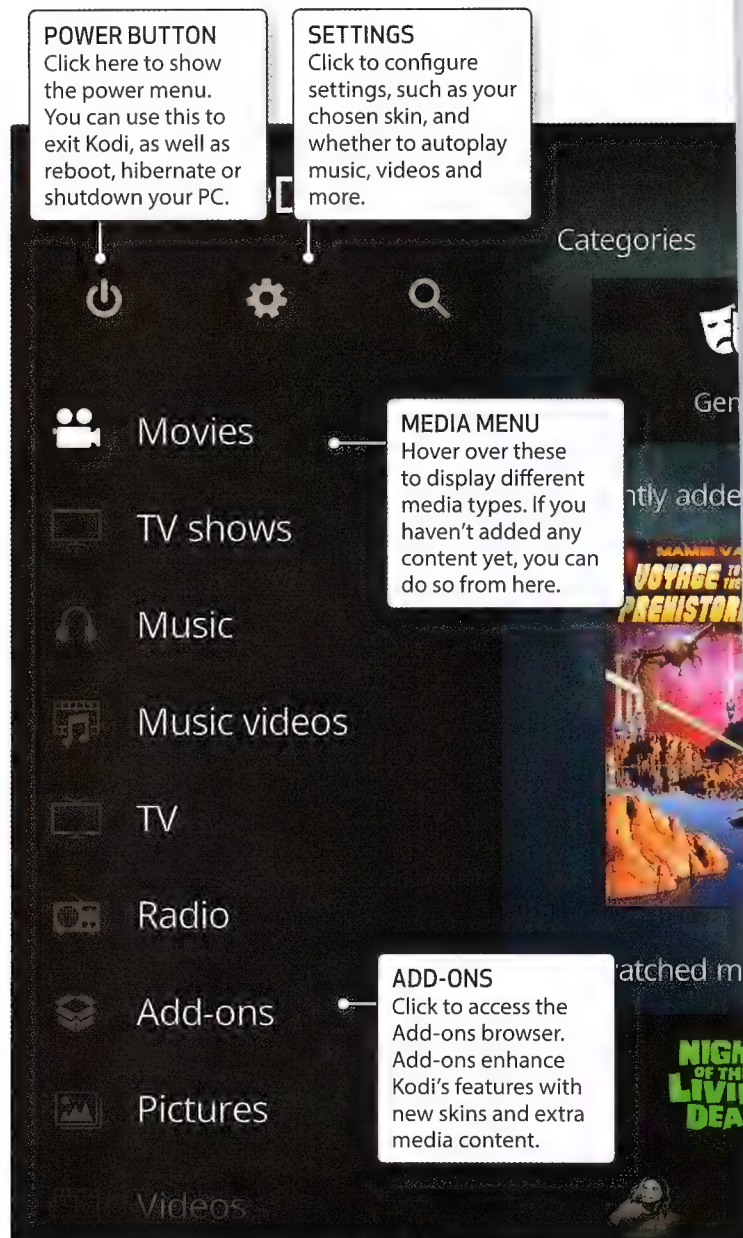
6 ADD TV SHOWS

Kodi will now ask if you want to refresh information for your items. Click 'Yes', then press [Esc] to go back to the main screen. Hover your mouse over TV Shows, then click Enter Files. Browse and select the folder containing your TV shows in exactly the same way as you did for Movies. In the Set Content window, click 'none' and specify that the content contains TV Shows.



7 ADD MUSIC

Kodi supports music playback. Press the [Win] key to show your Taskbar or exit Kodi and navigate to your music. Name tracks using the 'Track number-Artist-Song name' format – 04-Toybox-Tarzan and Jane, for example. Relaunch Kodi and choose Music, then Enter Files. Enter the path to your music folder in the same way as before. Under 'Set Content' choose Music.



8 INSTALL THE YOUTUBE ADD-ON

Kodi supports extra features, including the official YouTube add-on, which can both search for and play videos. Return to the main menu and choose 'Add-ons' > 'Enter add-on browser'. Select 'Video add-ons', then scroll down to YouTube. Double-click and select Install. You can now access YouTube from the Add-ons menu. Click Search > New Search to look for videos.

CATEGORIES

These are useful if you have a lot of videos. You can sort content by genre, alphabetically and much more.



Title



Year

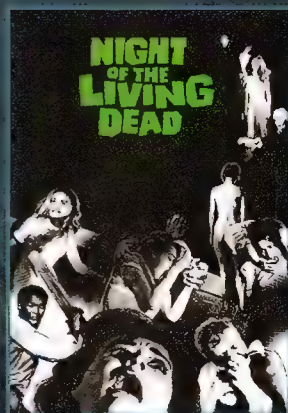
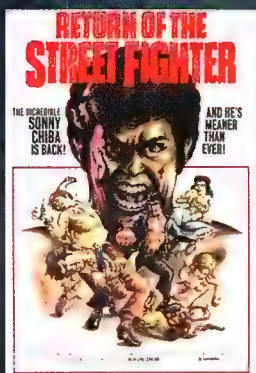
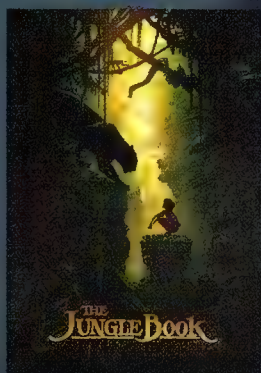


Actors



Directors

12:32 PM



LISTINGS

Shows content you have recently added and watched, as well as a small progress bar under videos you've started.

Jargon buster!

ADD-ONS

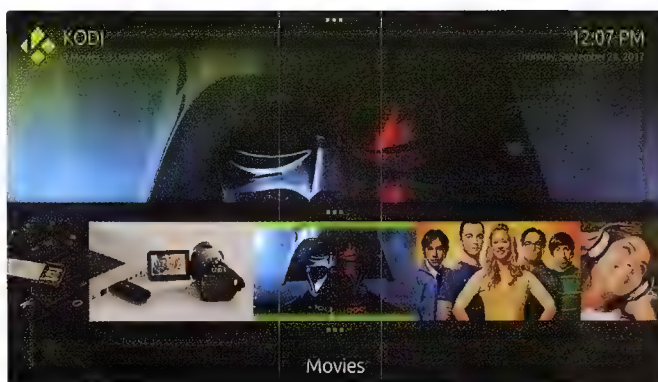
Any one of a number of apps designed to enhance Kodi, such as YouTube support. Some add-ons are maintained by the Kodi developers. Others are created by the community.

SKIN

The visual interface for Kodi. You can change the default skin, Estuary, via the Add-ons browser.

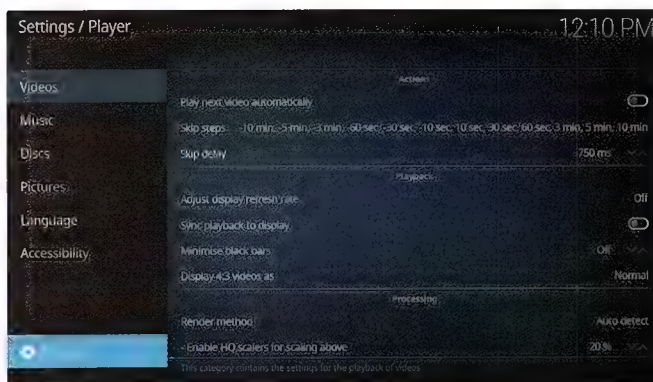
KRYPTON

The codename for the current version of Kodi. The layout and menu options are different to previous releases.



3 CHANGE SKIN

In Kodi, your chosen skin governs the look of the graphical user interface you use to manage and play your content. This includes the layout of menus, the background and, in some cases, extra icons and features. By default Kodi uses the rather austere Estuary skin. But you can change this to something more visually appealing. To do that, head to 'Add-ons' > 'Look and Feel' > Skin.



4 CONFIGURE SETTINGS

Click the Settings icon at the top left to change Kodi's settings. The menus are categorised so this should be fairly self explanatory. For instance, to optimise Kodi for use with touchscreens go to Skin Settings > General > Touch Mode. You can also fine-tune your playback settings. Click the button at the bottom-left to switch between Basic and Advanced settings.



Speed up Spotlight searches

Alan Stonebridge explains how to find things more quickly, on your Mac or online.

Spotlight searches more than just the folders and files (and files' contents) on your Mac. These days, it can look up pages on the web (and supports advanced syntax used by the likes of Google), Wikipedia, word definitions, and much more.

The trouble with Spotlight's power is

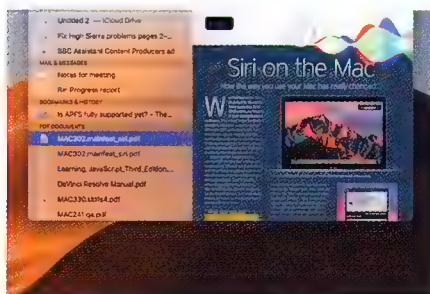
that its results can get a bit crowded. Sometimes you won't be able to think of good keywords to get better results on the spot. It's more likely that you'll move a hand to your mouse or trackpad to scroll through the long list and look for whatever it is you want.

However, you can quickly inspect the list of results without reaching for

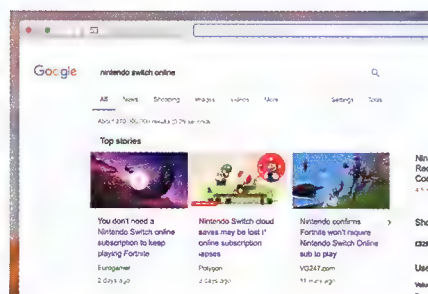
another input device, and save even more time if what you want is a web page, a Wikipedia entry, or a word definition. That's because Spotlight has hidden keyboard shortcuts that take you directly to the result you want without taking your hands off the keyboard. So, press command+spacebar and let's get down to it.

How to

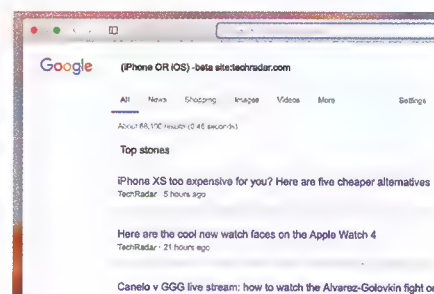
Save time in Spotlight.



1 NAVIGATE SEARCH RESULTS
Type your search terms – nothing too specific; we want broad results. Use the up or down arrow key to move to the item in the corresponding direction. Add Command to jump to the next category. Press Return to open what's selected.

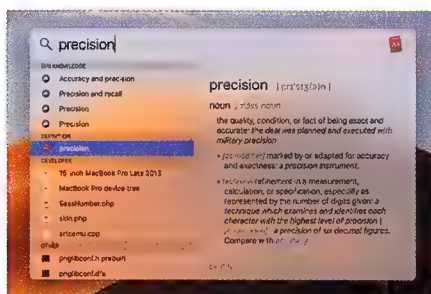


2 SEARCH THE WEB
You don't even have to switch to your web browser to start searching online. With your search terms typed in Spotlight, press Command-B to send them to whatever web browser and search engine are set as your defaults.

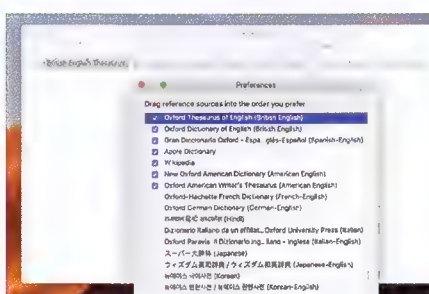


3 ADVANCED SEARCHES
You can make use of special syntax allowed by Google and other engines. So, sending (iPhone OR iOS) -beta site:techradar.com to your browser returns TechRadar pages that contain 'iPhone' or 'iOS', but not 'beta'.

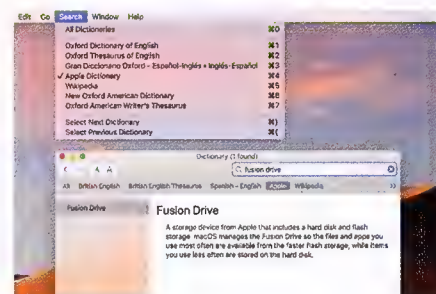
"The trouble with Spotlight's power is that its results can get a bit crowded. Sometimes you won't be able to think of good keywords to get better results on the spot."



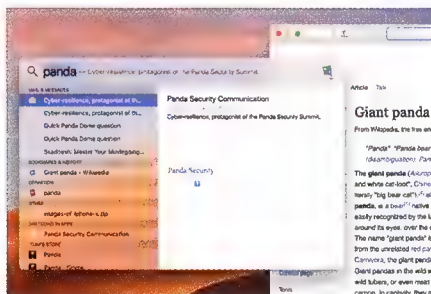
4 GET A WORD'S DEFINITION
Press Command+L to jump directly to the dictionary definition of what you've typed, if one is among Spotlight's results. Or, press Command-D to open the definition in the Dictionary app (again, if there's a matching result).



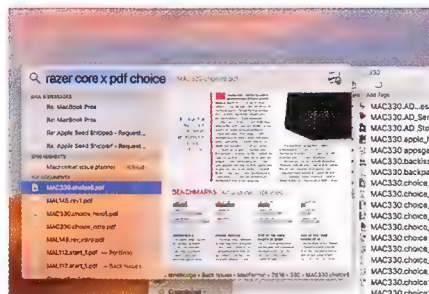
5 ALTERNATIVE WORDS
If you want a synonym rather than a definition, use Command-D to open Dictionary. You can switch between dictionaries and thesauri. First, choose which sources are listed and in what order in Dictionary > Preferences.



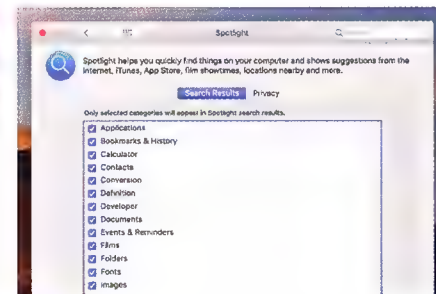
6 SWITCH SOURCE
Keep your hands on the keyboard while in Dictionary: Command-O selects All, Command-1 to Command-9 select items to the right (1 being the next to the right of All). Or, hold Command-up and press } or { to move right or left.



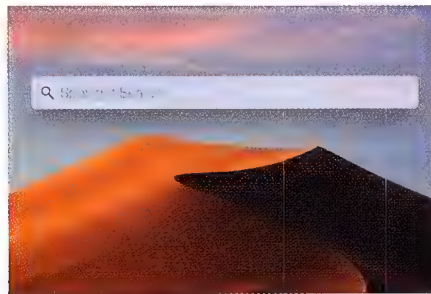
7 SEARCH WIKIPEDIA
To bypass a search engine and go straight to Wikipedia, type what you want to find out more about and press Command-K. If no corresponding Wikipedia page exists, you won't be switched to your web browser at all.



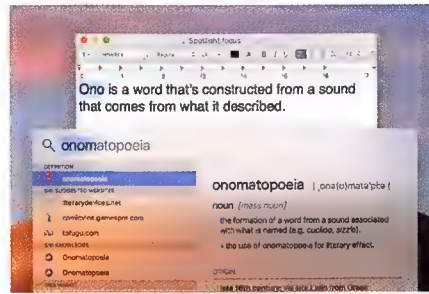
8 REVEAL FILE IN FINDER
If it's a file that you're looking for, but you don't want to open it, select it in the results and press Command-R to open a Finder window with the file selected. Similarly, to find out more about a file, press Command-I to open an Info window.



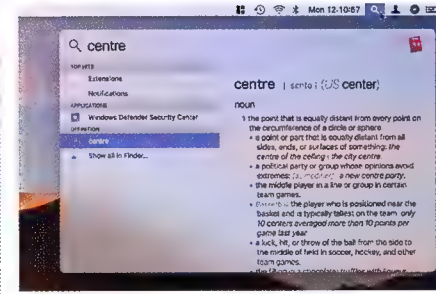
9 OPEN SPOTLIGHT'S PREFS
Finding a particular kind of item is cluttering results? With Spotlight open, you can jump directly to its pane in System Preferences by pressing Command-, (comma). That's the same shortcut used in most apps to open their preferences.



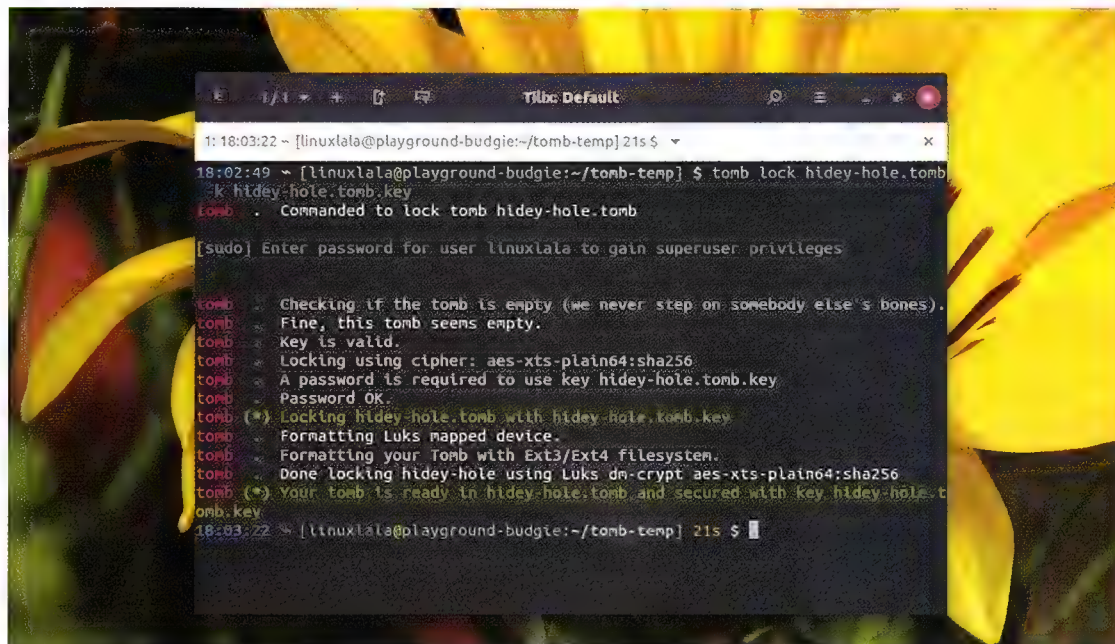
10 EMPTY THE BAR
You could press Command-A to select what's typed in Spotlight and then Backspace to clear it, or simply press Esc. Where that would close many other dialogs right away, in Spotlight it empties the bar.



11 CLOSE SPOTLIGHT
The window only closes if you press Esc a second time, or if the bar is already empty. Pressing Command-., (full stop) or Spotlight's key combo. The input focus is passed back to whatever had it before Spotlight.



12 ADJUST POSITION
Want to reposition Spotlight's window? The most reliable place to drag from is the magnifying glass icon at its top-left corner. If you want to reset it to the centre, click and hold on Spotlight's icon in the menu bar for a second or so.



For a complete list of options, and to understand why Tomb dislikes swap space, you must refer to the project's main page.

Speedy encryption

Hiding data may be difficult for mere mortals in this connected world, but it's a no-brainer for master Bash ninjas like Shashank Sharma.

There was a time when, for most people, the greatest fear of the modern world was catching a cold on public transport. But times have changed, and now our common dread is losing irreplaceable data – either accidentally, or through it being stolen.

As more people opt for digital banking transactions done from the comfort and convenience of a cellphone, the manufacturers have had to resort to measures such as fingerprint sensors to help you guard your secrets on the mobile device. But what about all the other data on your laptops and desktops? One easy solution to gain peace of mind is to use encryption to forever lock away all your precious secrets, whether it's files, bank statements, or family photos.

Using Tomb, you can easily store all important data in encrypted, password-protected directories. Such directories are referred to as tombs in the tool's parlance, and you can create as many tombs as you like, and even expand the size of an existing tomb if you need more space to safeguard your data.

INSTALLING TOMB

The command-line utility has a fairly straightforward installation, but you must fetch all of its dependencies first. Apart from `zsh`, the tool also requires `gnupg`, `cryptsetup` and

`pinentry-curses`. The last of these, `pinentry-curses` is a utility that's used for securely providing passwords and pins.

With the exception of `pinentry-curses` and `cryptsetup`, you probably already have the other dependencies installed on your Linux desktop. In any event, all of them are distributed in the software repositories of most popular distributions and can be installed by running the `sudo apt install zsh pinentry-curses cryptsetup` or the `sudo dnf install zsh pinentry-curses cryptsetup` command on Ubuntu/Debian and Fedora, respectively.

Now head over to <https://files.dyne.org/tomb> and download the latest source tarball:

```
# wget https://files.dyne.org/tomb/Tomb-2.5.tar.gz
# tar zxvf Tomb-2.5.tar.gz
# cd Tomb-2.5
# sudo make install
```

Assuming all the dependencies are already in place, the last command in the code block above will install the utility. The reason why installing Tomb doesn't require running the `./configure` and `make` commands, as you must when install other packages from source, is that Tomb is merely a script. You can place the tomb script found in the extracted Tomb-2.5 directory anywhere in your `$PATH` to be able to execute it. Running `sudo make install` merely copies this script

into the `/usr/local/bin` directory and makes it possible for you to access the man page.

HIDING SECRETS

With all the preliminaries out of the way, you can begin creating tombs to hold your secrets. For each tomb you create, you must also create a security key to lock its content. Each keyfile in turn is password-protected for additional security. For obvious reasons, you should never keep your tombs and associated keyfiles in the same directory.

The first step is to carve space for a tomb, and you must do this with the `tomb dig` command:

```
# sudo tomb dig -s 100 hidey-hole.tomb
# tomb dig -s 150 hidey-hole.tomb
tomb . Commanded to dig
tomb hidey-hole.tomb
tomb (*) (Creating a new tomb
in hidey-hole.tomb
tomb . Generating hidey-hole.tomb of 150MiB
150+0 records in
150+0 records out
157286400 bytes (157 MB, 150 MiB) copied, 1.4048 s, 112 MB/s
-rw----- 1 linuxlala
linuxlala 150M Oct 25 17:26
hidey-hole.tomb
tomb (*) Done digging hidey-hole
tomb . Your tomb is not yet ready, you need to forge a key
```


and lock it:

```
tomb . tomb forge hidey-  
hole.tomb.key  
tomb . tomb lock hidey-  
hole.tomb -k hidey-hole.tomb.  
key
```

As you can see from the code block, each tomb you create must have the .tomb extension. The -s command option expects a numerical value, which denoted the size of the tomb in MB. Apart from informing you of successfully creating a tomb, and its default permissions, the project also informs you the commands you must run next. Look for these in the bottom two lines in the block.

The tomb forge command is used to create a key for the specified tomb. The keyfile has a .key extension, but otherwise retains the same name as the tombs you create using the tomb dig command. The forge command will create a key using the AES256 cipher algorithm. The process may take some time, depending on the size of the tomb. It also helps if you keep using the machine to generate sufficient entropy. After some time, you'll be prompted to provide a password. Depending on the pinentry tool installed on your distribution, this may be either through a graphical dialog box, or a curses-driven interface.

When generating a keyfile, tomb will complain and terminate if it detects swap space on your hard disk. You must either use the -f command switch to force the tool to generate a keyfile, or alternatively run the sudo swapoff -a command to turn off swap. You can then run the tomb forge command again to generate the keyfile.

But wait, we're still not done. Now that you have a key, you must lock your tomb with the tomb lock hide-hole.tomb -k hidey-hole.tomb.key. This command formats your encrypted tomb with the Ext4 filesystem.

By default, all tombs are mounted in the /media directory. To open a tomb, you must run the sudo tomb open -k hidey-hole.tomb.key hidey-hole.tomb.

You can now add all the files you wish to keep secret into the mounted tomb directory. You can use common file operations such as copy or move to place files into your mounted tomb. When done, remember to close the tomb with the tomb close command.

WORKING WITH TOMBS

You can run the tomb list command to list all open tombs. In addition to providing a list of open tombs, this command will also inform you how long a tomb has been open, its total size and available free space.

With time, your tombs will grow to

Hiding keyfiles in images

Steganography is a process of hiding information such as messages, files and images in other files or images.

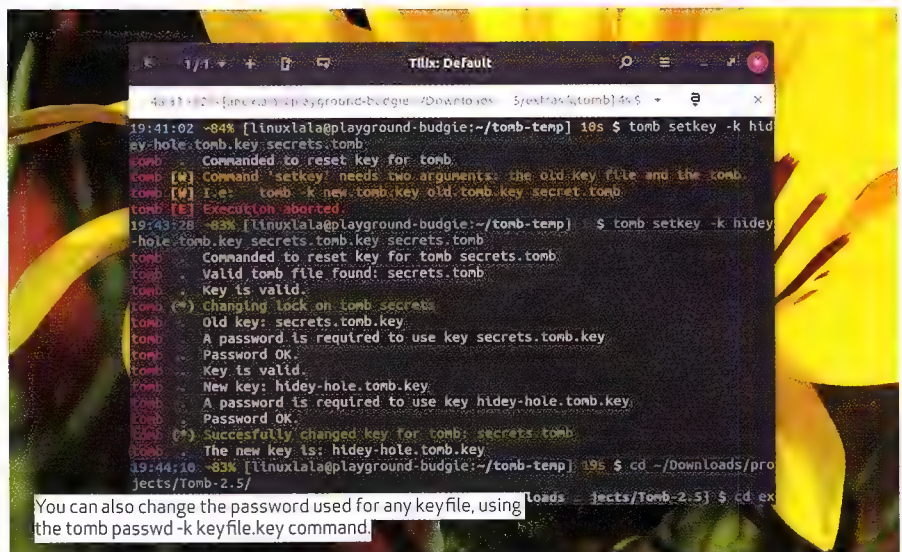
The advantage of using Steganography is that it's nigh-on impossible to tell if any image or file holds secret information. Compare this with regular cryptography, such as the one deployed with Tomb to create the keyfile. Due to its very name, having a .key extension, the keyfiles can easily be identified, and subjected to attacks such as brute force to break their password protection.

Wouldn't it be great if you could mask your keyfiles within seemingly benign files? Thankfully, Tomb makes it quite easy to bury keyfiles within JPEG images, using the steghide utility, which you can install from your distributions software repositories.

Once installed, you can use the tomb bury -k hidey-hole.tomb.key imagename.jpg command.

The command also retains the original keyfile, but you can now choose to lock or open the tomb using the image file instead: tomb open -k ~/Pictures/Wallpapers/P1040866.JPG hidey-hole.tomb.

Should you decide to extract the keyfile from an image, you can do that with the tomb exhum command. The command expects two arguments. You must provide a name for the keyfile to be extracted from the image. This could be the same, or different from the original keyfile name. You must also provide the name of the image file that was used to bury the keyfile: tomb exhum -k keyfile.key imagename.jpg. The associated keyfile will be extracted only if you correctly input the password associated with the keyfile.



contain different files. While the tombs are still open, run the tomb index command, which will create or update the search index if one already exists. Once you create an index, you'll be able to use the tomb search <pattern> command to search for files within the open tombs. The pattern can be any string, and the tool will attempt to match it against the filenames in the index for all open tombs.

If you don't want to index any particular tomb, you must first open it and then run the touch .noindex command from within the tomb's directory. Tomb will automatically skip indexing all tombs where it detects a .noindex file:

```
$ tomb index
```

```
tomb (*) Creating and  
updating search indexes.  
tomb . Indexing [hidey-  
hole] filenames...  
tomb . Search index  
updated.  
tomb . Skipping [hole] (.  
noindex found).  
tomb . Indexing [secrets]  
filenames...  
tomb . Search index  
updated.
```

While fairly straightforward, the project also ships with various additional tools such as GTK tray icon, and gtomb, which is a script that launches a graphical frontend of the tool. You'll find these, and more, sitting in the extras directory that lies within the extracted Tomb-2.5 directory. ■

Playing with blocks Minecraft style

Les Pounder spent the weekend hacking *Minecraft* in a classroom full of kids, and here are the hacks that the kids wanted!

As a learning tool, *Minecraft* is awesome. Kids play the game and learn how to create blocks of lava, diamond and water. But for younger players, the syntax of the commands is difficult. So for our project this issue we shall create an easy-to-use series of commands, cheekily called *Minecraft Zero* after GPIO and GUI Zero libraries, that enable kids to simply have fun, and learn a little Python along the way.

On your Raspberry Pi, open the Python 3 editor, found in the Programming menu. Once opened, click File>New to create a new blank document. Now click File>Save and call the file *mczero.py*. Remember to save your progress regularly.

Our project is made up of a series of functions, blocks of Python code that we can use by calling their name. The first of these is the most simple, and that's to post a message to the *Minecraft* chat window. As with all functions we need to define a name, and we shall call it *chat*, but you will see *msg* in parenthesis. This *msg* is the text we want to display in the chat window.

```
def chat(msg):
```

Inside the function we then use *Minecraft*'s library, which we shall later import and rename to *mc*, *postToChat* function. Note that we also use a *str()* helper to ensure that any data used for messages is converted to a string because the *postToChat* function only works with strings:

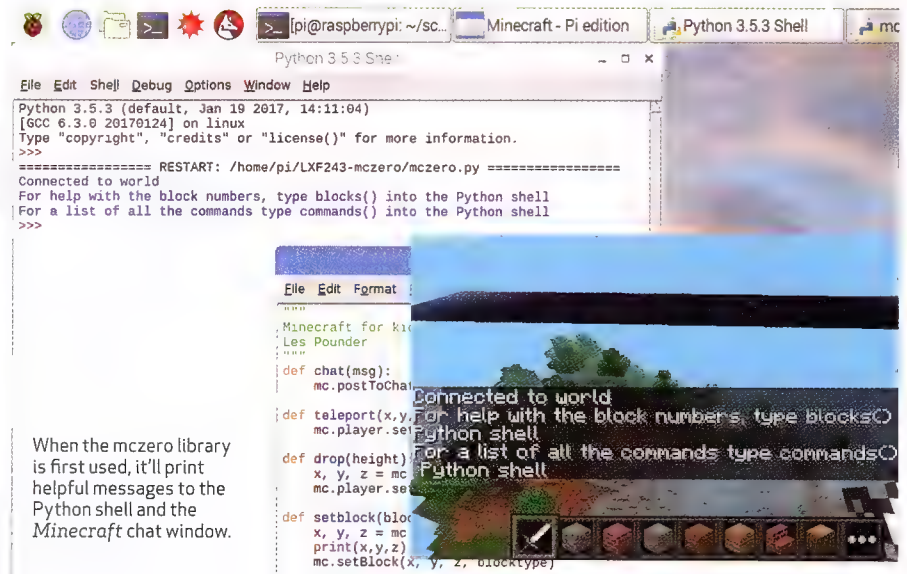
```
mc.postToChat(str(msg))
```

TAKE A TRIP

The next function is called *teleport* and it's used to send the player to any point in the world. All it needs are *x*, *y*, *z* coordinates, found in the top left of the screen. This function works in a similar manner as *chat* in that we invoke the function with a parameter which is the *x*, *y*, *z* position. Then in the function we set the position of the player (*setPos*) to those coordinates:

```
def teleport(x,y,z):
    mc.player.setPos(x, y, z)
```

Kids love to soar high into the sky, and then fall back to the world. Well,



When the *mczero* library is first used, it'll print helpful messages to the Python shell and the *Minecraft* chat window.

with the *drop* function we can do that. This function takes a parameter, the height (in blocks) to drop Steve from. This is then used in the function after we first learn of the player's current position using *getPos* to update the *x*, *y*, *z* coordinates. Then using *setPos* we change the value of *y* so that it's increased by the value of height.

```
def drop(height):
    x, y, z = mc.player.getPos()
    mc.player.setPos(x, y+height, z)
```

The next important part of *Minecraft* is changing blocks. Using Python we can edit any part of the world, changing grass to flowing lava, diamond or gold. To do that we need to alter the blocktype and our *setblock* function handles this by changing the block on which we're stood to anything that we pass as a parameter. If you don't know the blocktypes (numbers) don't worry, we cover that in our *blocks()* function later.

```
def setblock(blocktype):
    x, y, z = mc.player.getPos()
    mc.setBlock(x, y, z, blocktype)
```

CUBES ON DEMAND!

Our *cube* function takes two parameters: the size of the cube (in

blocks) and the type of blocks it's made from. So we can create cubes of diamond and use them to obstruct our enemies! In this function we use *setBlocks* and give two *x,y,z* positions. The first being the player's position plus one block on each axis, and the second position being the player's position plus the size of the cube. *Minecraft* then fills in the values between them to create a solid cube, like so:

```
def cube(size,blocktype):
    x, y, z = mc.player.getPos()
    mc.setBlocks(x+1, y+1, z+1, x+size, y+size, z+size, blocktype)
```

But what if you want a big, hollow cube? Well, our *hollow_cube* function will do that for you. It creates a solid cube of diamond blocks (blocktype 57), and then we create a smaller hollow cube inside it using a cube of air blocks (blocktype 0):

```
def hollow_cube(size):
    x, y, z = mc.player.getPos()
    mc.setBlocks(x+1, y+1, z+1, x+size, y+size, z+size, 57)
    size = size - 2
    mc.setBlocks(x+2, y+2, z+2, x+size, y+size, z+size, 0)
```


TICK, TICK, BOOM!

This function creates a trail of active TNT that follows your every step. When you hit it with a sword, it explodes! For this we need to get the players position, then set the block at their feet to TNT (blocktype 46), but we need to also pass the value 1 so that the TNT can be explosive. Then we sleep for 0.1 to slow down the number of TNT blocks on screen. This function is best used inside a while True: loop so that it continuously runs.

```
def tnt_trail():
    x, y, z = mc.player.getPos()
    mc.setBlock(x, y, z, 46, 1)
    sleep(0.1)
```

Our tnt_cube function creates a cube that's full of TNT! Just pass the size parameter, hit the cube and run! Note that on older Pi, the maximum size should be 10x10x10. For Pi 3 you can risk 20x20x20, but bear in mind that it may lock up the Pi:

```
def tnt_cube(size):
    x, y, z = mc.player.getPos()
    tnt = 46
    mc.setBlocks(x+1, y+1, z+1, x+size, y+size, z+size, tnt, 1)
```

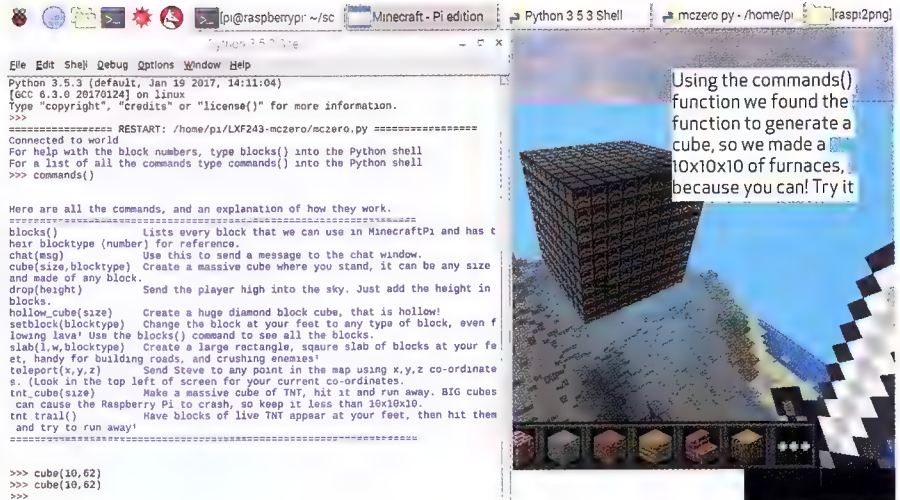
Building long lines of blocks is boring! But with our new slab function we can create large slabs of blocks by passing the length (l), width (w) and the blocktype. Essentially, this is the same as our cube function, but the value of y never changes, which forces the slab to be built in only two axes:

```
def slab(l, w, blocktype):
    x, y, z = mc.player.getPos()
    mc.setBlocks(x+1, y+1, z+1, x+w, y+1, z+1, blocktype)
```

The last in-game function is called fire_feet and it places flaming torches (blocktype 50) at your feet wherever you go. This is best used with a while True loop, just like the tnt_trail function.

```
def fire_feet():
    x, y, z = mc.player.getPos()
    mc.setBlock(x+1, y, z+1, 50, 1)
    sleep(0.1)
```

The next two functions are built-in help tools. The first is called blocks() and it stores a dictionary (called block dictionary), a data type to store large amounts of data that are referenced via a key:value relationship. In this case the keys are the names of the blocks, and the values are the blocktype numbers. So, for example the key AIR return the blocktype 0. There are loads of different blocks in the dictionary, and to show them all we use a for loop that will iterate over each of them and



print the key and value, with a 0.1 second pause between each line. You can find the code listing for this function in the download for this project.

The final function is called commands() and it simply prints out all of the commands and what they do. Handy to remind ourselves when in the middle of battle! You can find the code listing for this function in the download for this project.

To run all of the code we use an exception handler, that will try to run the code. In this case it will import the Minecraft library, the block library and import sleep from

the time library. Then it creates a connection to the running Minecraft game. If this works then text is displayed in the Python shell and Minecraft chat window advising the player of the help functions (blocks() and commands()), but if the connection fails then an exception is raised and an error is printed to the shell.

Save the code, launch a Minecraft game and when you're in the world, click Run>Run Module in the Python editor. Now try out the commands and prepare to cause havoc and mayhem! ■

"Kids love to soar high into the sky, and then fall back to the world. Well, with the drop function we can do that."

Adding the code to a project

Our mczero.py code can be used via the shell, for an interactive battle of skill against other players.

But it can also be used as part of a project in the same manner as we import other libraries of code, for example when we import the Minecraft (mcpi) library into our mczero.py code. To do this we need to ensure that any code that we create is saved in the same directory as the mczero.py file. To start we import the mczero library:

```
import mczero
```

Then we can use any of the functions in our code by calling their names, preceded by the name of the library, in this case mczero. For example let's pop a message in the chat window:

```
mczero.chat("Hello Linux Format")
```

Then let's create a loop for our fire_feet function:

```
while True:
    fire_feet()
```

Any code that we wish to continuously run can be placed inside the loop, so our tnt_trail() and fire_feet() functions can be run together. However, for the larger functions, that create cubes, slabs and so on, they should ideally be run once, or on demand using a conditional statement (if..elif..else) For example, one that checks for the type of block that the player is standing on.

New Smartphone Battery Secrets 101

Want maximum run time from your phone battery? There's more to it than dimming your screen. Darren Yates delves into the science of maximising mobile battery life.

It'd be fair to say most of us don't consider the batteries powering our portable devices until they run out of charge. Just like a power supply unit in a desktop computer, phone batteries are indispensable – yet the chances are when it comes to the components inside a phone, the one we least understand is the battery. We've all heard the 'hot tips' on maximising device battery life from 'dim the screen' to 'turn off GPS'. However, there are other factors that can have far greater effect. This month, we dive into battery science to squeeze more power out of your device battery – and give it longer life.

LI-ION OR LI-POLYMER?

The goal of longer battery life really is a science – and it starts with battery construction. With most phones now featuring non-removable batteries, understanding even just the basics will help you maximise its lifespan. When it comes to phones, you'll find two common classes of Lithium-based rechargeable battery – Lithium-ion (Li-ion) and Lithium-Polymer (LiPo). The difference? Not much, as it turns out. Keeping it short, a battery has an anode (-), a cathode (+) and a substance called an 'electrolyte' to facilitate electron flow. There are many different Li-based battery types depending on the chemical compounds used to create the anode and cathode electrodes. For example, the new Panasonic 18650 cells inside Tesla cars use a cheaper and more effective Nickel-Manganese-Cobalt (NMC) cathode. However, the practical differences between Li-ion and LiPo batteries in phones are more to do with construction. Here, the 'polymer'



This battery for the Motorola Moto G5 phone has a 3.8-volt nominal voltage.

AccuBattery

Battery health

By comparing the estimated battery capacity versus the design capacity, you can see how much capacity (mAh) your battery has lost over time. To change your battery design capacity, go to the charging screen.

Battery health	99%
Estimated capacity	2,771 mAh
Design capacity	2,800 mAh

Based on 27 sessions with 1,194% charged for 33,091 mAh total.

Battery capacity

Current battery capacity is measured by how much electricity (mAh) and percentage (%) of battery is added in the charge session.

AccuBattery on Google Play advocates you stop charging at 80% capacity.

DISMISS

Charging Discharging Health History

generally refers to the cell packaging, allowing a higher energy density per unit volume.

NOT TOO COLD, NOT TOO HOT

You don't have to read too many 'my phone won't charge' stories on the web to know Lithium-based batteries are, shall we say, particular about their conditions. For starters, they don't like heat – and by 'heat', we mean anything much over 30-degreesC. Prolonged exposure to temperatures above this level not only reduces the charge capacity, but also reduces the battery's lifespan. That means you'll need to recharge it sooner, but also you won't



New Li-NMC cells like this Panasonic 18650 power Tesla electric cars.



get as many charge-discharge cycles before it goes belly-up.

This has ramifications for high-demand applications, particularly gaming. Playing high-performance games requiring plenty of processing power raises the temperature of the CPU and GPU cores inside your phone's processor chip. Given the proximity of the battery to the main circuit board and chip in most phones, a rise in battery temperature is almost unavoidable.

Yet Lithium-based batteries don't like being too cold, either. Australian Research published last year by RMIT University showed Li-ion batteries can lose as much as 23% of their capacity when operated at -15degreesC (tinyurl.com/y7pdmqhd). Not only that, but colder batteries take longer to charge. The internal chemistry of the battery cell changes at lower temperatures, increasing its internal resistance, which reduces the amount of charge current they can accept, pushing out charge times. Sure, most of us don't live at -15degreesC, but it's a progressive thing – the colder the battery, the lower its capacity becomes (it's also an issue for electric cars).

So what's the ideal temperature? It turns

out the sweet-spot is about 20-degreesC – that gives you the maximum capacity as well as longest life-span. Much either side of that mark and you start to lose either way.

OVER-CHARGING

Another thing Lithium-based batteries don't like is being over-charged – and this can mean charged too fast as well as charged for too long. All phone batteries have protection circuitry built in that automatically prevent this from occurring, but there's still debate over what constitutes 'too much charge'. Phone makers obviously want a safe battery, but they also want to pack in enough energy to ensure decent battery life. A smartphone battery features a single cell with a nominal cell voltage of 3.6 or 3.7-volts. When you plug in your phone charger, it pumps electrical current into the cell, which progressively raises its voltage. Once it reaches 4.20-volts, the charge current is cut and you've reached full-capacity. However, there's argument that 4.20-volts is too high, that it causes battery stress and that stopping a charge at 4.05-volts is better in the longer term. You'll find apps on Google Play like AccuBattery (tinyurl.com/y7x55tsh) similarly advocating you unplug your phone once its charge level reaches 80%, rather than letting it hit the 100% end-stops. In fact, according to Battery University (tinyurl.com/ybxb662q), for each 0.1-volt below 4.2-volts you drop the peak charge voltage, you double the charge cycle lifespan. That means while charging to 4.20-volts will get you 300-500 charge cycles, charging to only 4.10-volts will bump that to 600-1000 cycles. Of course, a battery charged to 80% requires charging sooner, but should pay you back in the long run.

However, it's not quite that simple. Recent developments have seen new Lithium-NMC batteries with nominal voltages as high as 3.8 and 3.85-volts. The higher voltage helps boost capacity and potentially allows a maximum charge voltage of 4.35-volts and 4.40-volts, respectively. So, battery chemistry determines the appropriate peak charge voltage, something phone makers take into account during their design phase.

Still, my Motorola Moto G5 with its 3.8-volt LiPo battery was shown by two apps – AccuBattery and Ampere – to be charging at 4.39-volts at a charge level of 91%. Does this constitute over-charging based on the arguments? You couldn't say for certain. Still, given the data available, I'm less inclined to go past a 90% charge level in future.

However, there is one thing everyone agrees on – you definitely don't want a 100% fully-charged battery exposed to excessive heat. That'll kill it as fast as anything else.

NO FULL CHARGE-DISCHARGE CYCLES

This also flows into that old chestnut of an idea that you must fully discharge and then fully charge your phone to get maximum battery life. It may have had some truth to it in the days of Nickel-Metal-Hydride (NiMH) batteries, but these full charge-discharge cycles do Lithium-ion batteries no favours. For a typical Li-ion cell, you'll get roughly 300 full-depth discharge cycles, but if you reduce the 'depth of discharge' to just 40%, you'll get around 1,000 cycles. Put all together, keeping your phone battery's charge level between 40% and 80% should be your best bet for achieving maximum life-span.

If you're up for it, a 2016 IEEE research paper from MIT and ETH Zurich called 'Modelling of lithium-ion battery degradation for cell life assessment' (tinyurl.com/ycomuzne) tests various charge level ranges and explains how it all works.

IS FAST-CHARGING SAFER?

Bigger phones have bigger screens, bigger screens need bigger batteries, bigger batteries need faster charge rates. Pretty much all phone chargers will slam a battery at a low-charge state with maximum allowable electrical current to pump the power in as fast as possible. However, once that rate reaches around 80%, the current rate is progressively reduced to protect the battery.

Your phone may have come with, or have an option for, a fast-charger that speeds up the charging process and reducing charge times, but there are two things to remember about this. First, fast-charging generally causes greater stress to the battery, including raising its temperature. The second thing is that fast-charging works best with batteries at a low-charge-state. Once a battery reaches a charge level of around 80%, fast-chargers are generally little better than standard ones, because essentially, it's the battery now controlling the charge rate to prevent damage to itself.

WHAT ABOUT WIRELESS CHARGERS?

Wireless chargers might seem convenient, but they also can have the added issue of generating extra heat. Inductive charging works by having two wire coils in close proximity. Energy pumped into the transmitting coil is picked up by or 'induced' in the receiving coil. The problem is that like all energy transfer systems, you don't get 100% efficiency, which means some energy is lost as heat. Given that the receiving coil is often close to the battery, that energy loss can result in increased battery temperature.



COST VS CONVENIENCE

If you're the type to replace your phone every two years like clockwork, you probably won't care how worn out the battery might be. But with plenty of top-end phones now pushing well north of \$1,000, non-removable batteries are hardly cause for celebration.

Some argue that it's only \$80 or so to send your phone back to wherever for a battery replacement, but that raises privacy and security concerns. A user-removable battery overcomes this problem.

BE SMART

Smartphone batteries have built-in protection smarts already, but you can help your phone battery last longer by following these five tips:

- Don't allow the phone temperature to fall below 10-degrees C or go above 30-degreesC for extended periods (and definitely don't leave it in the car).
 - Aim to maintain a phone charge level range of between 40 and 80% (yep, you're reducing the capacity and run-time but it reduces battery stress longer-term).
 - Don't fully discharge your phone before charging it (the battery lifespan will be longer with 'partial' charges rather than full ones).
 - Definitely don't fully-charge the battery and expose it to high temperatures.
 - Grab a good battery monitoring app like AccuBattery.
- So, in short, a fully-charged battery is bad; a fully-charged battery that's hot is worse. No matter how great your phone is, it won't work if the battery's shot. Lithium-based batteries are fussy and you'll likely lose some lifespan if you don't look after it. ■

An introduction to R – Part 3

Machine-learning can be applied to almost anything – even house prices. Darren Yates introduces matrices, data frames and regression analysis to predict home sale prices.

If there's a topic that grabs attention, it's real estate. Whether you're trying to up-size, down-size or just plain get into any size, real estate in Australia isn't for the faint-hearted. If you've ever been to a home auction, even if you're just there to sticky-beak, no doubt you've tried to predict the final sale price. Real estate agents probably get closer than most of us, thanks to their background or 'domain' knowledge. The question we ask this month is can we predict a house sale price using just machine-learning.

CLASSIFICATION VS REGRESSION

So far in this series, the prediction tasks we've worked on have all been about predicting a category class. For example, in the Kaggle Titanic competition dataset, we were looking to predict whether a particular passenger survived or not. If we were in the weather forecasting business, we'd be trying to predict whether or not it will rain tomorrow. These are forms of machine-learning known as 'classification' – we're trying to learn the pattern that most accurately

categorises data into various classes. This time, we're not interested in a category-based prediction result like 'yes/no', but a numerical one – the house sale price. For this, we need a technique called 'regression analysis'.

THE DATA

This question of predicting house

prices with machine-learning isn't new – in fact, it dates back at least 40 years, when the 'Boston Housing' dataset was published in a 1978 research paper. The data science competition site, Kaggle, has a beginner's competition that uses a more recent housing dataset based on home sales in the U.S. town of

```

1 # House Prices - V1 - Kaggle competition script - version 1
2 # Darren Yates 22 October 2018
3 # Import libraries
4 library(randomForest)
5 library(forecast)
6
7 # Load data files from downloaded 'all.zip' file from kaggle.com
8 train <- data.matrix(read.csv(file.path("c:\\users\\darren\\downloads\\all", "train.csv")))
9 test <- data.matrix(read.csv(file.path("c:\\users\\darren\\downloads\\all", "test.csv")))
10
11 # Create train and test subsets from the train file above
12 set.seed(3800)
13 sample_train <- sample(nrow(train), size = 0.66, nrow(train))
14 set_train <- train[sample_train,]
15 set_test <- train[-sample_train,]
16
17 # Build RandomForest model from the set_train subset using 100 trees
18 model_ranFor <- randomForest(set_train[, "SalePrice"], data = subset(set_train, select = -SalePrice),
19                             importance = TRUE, ntree = 100, nodesize = 7, na.action = na.roughfix)
20
21 # Test model against the set_test remainder
22 pred <- predict(model_ranFor, newdata = subset(set_test, select = -SalePrice))
23 print(accuracy(rf.pred, set_test[, "SalePrice"]))
24
25 # Now run the model of the actual 'test' dataset, write prediction_output to csv file
26 # and upload to Kaggle
27 model_prediction <- predict(model_ranFor, test)
28 prediction_output <- data.frame(Id = test[, "Id"],
29                                SalePrice = model_prediction)
30 write.csv(prediction_output, file = "SalePrice_V1.csv", row.names = FALSE)

```

> source("~/R/scripts/462/houseprices-v1.R")
Download our simple R script solution at <http://apcmag.com/magstuff>.

Overview **Data** Kernels Discussion Leaderboard Rules Team My Submissions

Sample submissions: a benchmark submission from a linear regression on year and month of sale, lot square footage, and number of bedrooms

Data fields

Here's a brief version of what you'll find in the data description file.

- SalePrice** - the property's sale price in dollars. This is the target variable that you're trying to predict.
- MSSubClass**: The building class
- MSZoning**: The general zoning classification
- LotFrontage**: Linear feet of street connected to property

Data (386 KB)

Name	Size	Type
sample_submission...	1459 x 2	
test.csv	1459 x 2	
train.csv	1461 x 2	
data_description.txt		
sample_submission...		

API kaggle competitions download -c house-prices-adv... **Download All**

About this file

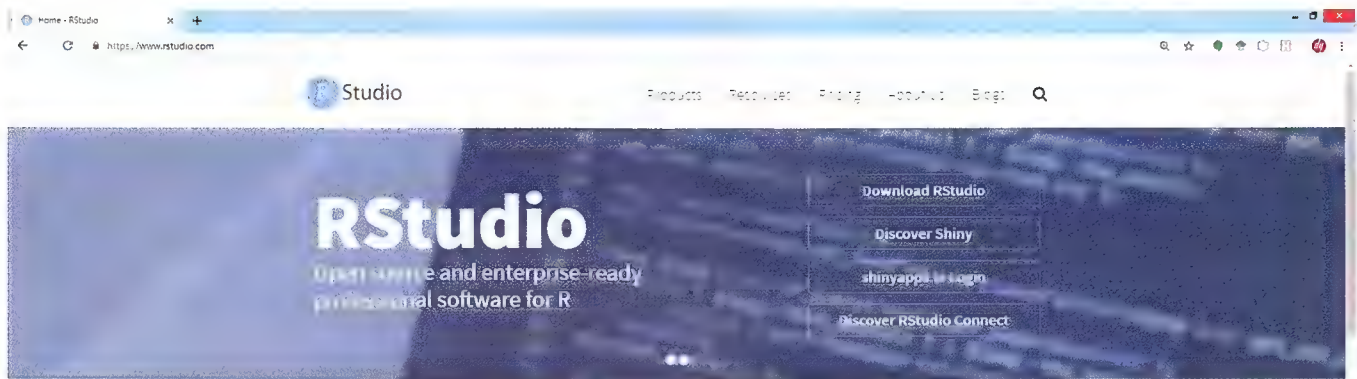
a benchmark submission from a linear regression on year and month of sale, lot square footage, and nuMSSubClass: Identifies the type of dwelling involved in the sale.

Columns

Column
Id
SalePrice

20 1-STORY 1046 & NEWER

Sign up to Kaggle, select the House Prices comp, choose 'Data' to get the data.



RStudio



Shiny



R Packages

Don't forget to install the R language before you install RStudio Desktop.

RStudio makes R easier to use. It includes a code editor,

Shiny helps you make interactive web applications for visualizing data. Bring R

Our R developers create popular packages to expand the features of R. Includes

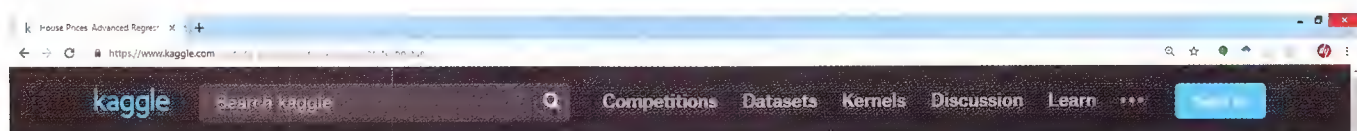
Ames, Iowa. It consists of nearly 3,000 records in two datasets for houses sold in the town, each with 80 factors or 'attributes' describing the house, everything from land zoning to the number of kitchens(!) to the type of roofing material. The last of those attributes in the training dataset is the sale price of the house. Our job is to find the pattern amongst the 1,500 records of the training dataset that links one or more of those attributes to the sale price and to turn that into a

mathematical equation or 'model'. We then run that model against the second set of 1,500 records in the test dataset to predict each sale price, submit our predictions to Kaggle and see how we stack up on the leaderboard.

QUICK SETUP

If you've missed the previous parts of our R intro, don't worry – setting up your system for basic machine learning is easy. We're using a combination of the R programming

language plus RStudio integrated development environment (IDE). They're both free and open-source, plus you'll find versions for Windows, Linux and macOS. The only thing you must do is make sure you install the R language first, followed by RStudio. The R language installer is available from the CSIRO's CRAN mirror at cran.csiro.au, the download for RStudio Desktop is at tinyurl.com/apc462-rstudio. Once they're installed, fire up RStudio.



House Prices: Advanced Regression Techniques

Predict sales prices and practice feature engineering, RFs, and gradient boosting

4,177 teams · Ongoing

Overview Data Kernels Discussion Leaderboard Rules

Overview

Description

Evaluation

Tutorials

Frequently Asked Questions

Start here if...

You have some experience with R or Python and machine learning basics. This is a perfect competition for data science students who have completed an online course in machine learning and are looking to expand their skill set before trying a featured competition.

Competition Description

Kaggle's House Prices competition will skill you up on regression analysis.

how to » machine learning masterclass

Overview Data Kernels Discussion Leaderboard Rules Team My Submissions

2904 new DarrenYates 0.15547 1 2m

Your Best Entry ↑
Your submission scored 0.15547, which is not an improvement of your best score. Keep trying!

Our first attempt placed us in 2904th position – not bad, considering.

Overview Data Kernels Discussion Leaderboard Rules Team My Submissions Submit Predictions

Make a submission for DarrenYates

You have 10 submissions remaining today. This resets 17 hours from now (00: 00 UTC).

Step 1
Upload submission file

Upload Submission File

Your submission should be in CSV format. You can upload this in a zip/gz/rar/7z archive, if you prefer.

We expect the solution file to have 1459 prediction rows. This file should have a header row. Please see sample submission file on the data page.

You can drag and drop your CSV file straight onto the submit webpage.

Step 2

B / % " </> H

Styling with Markdown

"To grab the data, you'll need to sign up to Kaggle – it's free and all you need is a Facebook, Google or Yahoo account, or just an email address and password."

GRAB THE DATA

To grab the data, you'll need to sign up to Kaggle – it's free and all you need is a Facebook, Google or Yahoo account, or just an email address and password. Next, head to tinyurl.com/apc462-kaggle. On the second-level horizontal menu, you'll see 'Overview', then 'Data'. Click on 'Data', scroll down until you see the 'Download All' link on the right-hand-side and click to download. Unzip the file to an easy-to-find folder and you'll find a number of files, the two most important for us are 'train.csv' and 'test.csv'. These are comma-separated variable files – 'train' is the one we'll use to learn our model and 'test' contains the records we need to predict the sales price for using our model. Once we're done, we upload our predictions.

Kaggle knows the sale prices for each house record in the 'test' dataset and it uses a mathematical test called 'root-mean-square-error' (RMSE) to

calculate just how far our predictions are from the actual sale prices. The closer we get to each actual sale price, the lower our model's RMSE and the higher we go up the leaderboard.

GET THE CODE

You'll find my simple solution to this Kaggle House Prices competition on our website at apcmag.com/magstuff. Load up 'houseprices_v1.R' into RStudio, but before you run it, click in the console area underneath the code editor and run the following code:

```
install.packages('randomForest')
install.packages('forecast')
```

The first download and installs the Random Forest library, the second installs the Forecast library we need for error-testing. Once

installed, you run our R script by clicking on the 'Source' icon at top-right of the code editor panel in RStudio.

MATRICES AND DATAFRAMES

Last month, we looked at some basic data structures in R – variables and vectors. A vector is data structure that contains a series of variables or 'elements' of the same type – they can be numeric, character or Boolean (true/false, also called 'logical'), but they must be all the same type. You can think of them as a column in a spreadsheet, but what if you wanted to store data in a two-dimensional spreadsheet-like structure? That's where matrices and dataframes come into play. In R, a matrix is like a spreadsheet, however, like a vector, every cell or 'element' in a matrix must have the same type of data – they must be all numbers or all characters and so on. So for example, you couldn't store the details of your workforce – age, sex, home address etc – in a matrix. However, you could store them in a dataframe. One way to think of a dataframe is as a list of lists. Each row is a record of a similar event or entity and each column is a factor or 'attribute' of that event/entity. So, again, if we're storing workforce details, each row would be an



House Prices: Advanced Regression Techniques

Predict sales prices and practice feature engineering, RFs, and gradient boosting
4,190 teams · Ongoing

Press the blue Submit Predictions button when you're ready to submit.

Overview Data Kernels Discussion Leaderboard Rules Team

My Submissions

Submit Predictions

Your most recent submission

Name	Submitted	Wait time	Execution time	Score
SalePrice_v1.csv	just now	0 seconds	0 seconds	0.15547
Complete				

Jump to your position on the leaderboard ▾

employee and the columns attributes of those employees, such as age, sex, address, as before. More relevant to us, a row can represent a house sold and each column an attribute such as land-zoning, number of kitchens – and finally, the sale price.

STRINGS AS FACTORS

One of the first things we do in our R script is load the data from those CSV files into memory using the `read.csv()` function. This does two things – first, it reads the file into a dataframe object, but it also turns all of the character values into factors. A factor is a numerical way of representing character-based data that works better with many machine-learning algorithms. For example, an attribute 'daysOfWeek' might have character values of 'Sunday', 'Monday', 'Tuesday' and so on, but in a factor variable, they'd be stored as integers 1 to 7. Yet, unlike a normal integer variable where you can store integer values into the billions, the integers stored in factors are called 'levels' and the number of levels is pre-determined by the number of distinct string values. So, for example, a factorised 'daysOfWeek' vector can only have factors 1 to 7 and no more, because there are no more days of the week. Factor level integers are automatically assigned in R to strings in alphabetical order (Friday as '1', Monday as '2' and so on).

BUILD MODEL SUBMIT CSV

We've commented the script, so you can follow what we do. In Section 1, we import the necessary libraries and Section 2, we read the data files into memory. Section 3 creates two

"Random Forest is a popular and versatile machine-learning algorithm normally used for classification learning, but it actually does a pretty decent job at regression as well."

subsets from the training dataset that we use in Section 4 to create and test our model – the training dataset is split 66-34 into separate training and testing subsets. The Random Forest algorithm builds our model in Section 4, creating 100 decision trees in the process. In Section 5, we use our new model against the initial test.csv dataset, storing our predictions in 'SalePrice_v1.csv' located in the 'My Documents' folder.

To submit the predictions, head to the 'House Prices' Kaggle page above, click on the big blue 'Submit Predictions' button on the right, drag your CSV file into the 'Upload Submission File' area, add some quick notes and press the 'Make Submission' button. You'll find a 'sample_submission.csv' file in the Kaggle data download to give you an idea of what your CSV should look like.

Random Forest is a popular and versatile machine-learning algorithm normally used for classification learning, but it actually does a pretty decent job at regression as well. It has the innate ability to automatically determine (to a large extent) the important attributes and relegate those we don't need, making it easy to use. There are other algorithms that

will outperform Random Forest, but it's a great 'go-to' multi-tool.

FINAL RESULT

After submitting our prediction file to Kaggle, it came back with an overall logarithmic RMSE score of 0.15547, placing us in 2,904th position out of the 4,190 teams taking part at the time of submission – not bad for a first attempt and frankly, better than expected. If we compare our RMSE score with others in terms of leaderboard position, a score of 0.10963 puts you in the top-50 and 7.09027 in the bottom-50. Our score is much closer to top-50 than bottom-50 and it should only need some feature engineering and tuning of our analysis to improve our result marginally and make a move up the leaderboard.

Our solution to Kaggle's House Prices competition is probably one of the shortest and the fact we're as high up the Kaggle leaderboard as we are with next-to-zero effort is all thanks to Random Forest. Regression analysis is an important skill to have in your machine-learning kitbag – but as we'll see, Random Forest is just one way to do it. ■

downtime

GAME NEWS IS SERIOUS NEWS.

Xbox One now has mouse and keyboard support

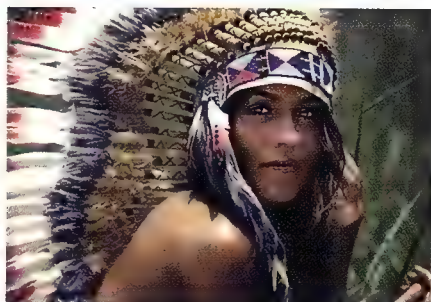
IN ITS CONTINUED EFFORTS TO MERGE THE PC AND XBOX ECOSYSTEMS, MICROSOFT FINALLY ROLLED OUT LONG-PROMISED MOUSE AND KEYBOARD SUPPORT FOR THE XBOX ONE.

Games will need to have the support patched in, but the likes of *Fortnite*, *Warframe*, *Vermintide 2* and *War Thunder* have been confirmed already. The announcement was made at Microsoft's special X018 event, which also brought news of the company's acquisition of Obsidian and inXile Entertainment – two very PC-oriented RPG developers. With both these studios under Microsoft's wings – and keeping in mind the forthcoming *Age of Empires* remake – the next Xbox generation is shaping up to be very different to Sony and Nintendo's. The X018 event also brought a confirmed February 15 release date for *Crackdown 3*, as well as the announcement of *Void Bastards*, a new tactical shooter by former Irrational Games devs. SP

Better red than dead

GAME SITE PAYS £1 MILLION TO CHARITIES TO 'APOLOGISE' FOR RED DEAD REDEMPTION 2 LEAKS.

In February, Trusted Reviews published *Red Dead Redemption 2* details from a leaked Rockstar document, and subsequently publisher TI Media has agreed to donate more than a million pounds to "unreservedly apologise" for the story. The money goes to charities chosen by Rockstar. "Because this situation involved information about *Red Dead Redemption 2*, Rockstar Games directed the settlement funds to these three great charities: the American Indian College Fund, the American Prairie Reserve, and the First Nations Development Institute."



The devil's in the details

Blizzard was expecting backlash for *Diablo Immortal*, but 'not to this degree'.

Blizzard was expecting some backlash following the announcement of its massively multiplayer *Diablo Immortal* mobile game, but "not to this degree", according to studio co-founder Allen Adham.

He said the reaction from fans came from a place of "passion", adding: "It's pretty clear that their incredible passion for *Diablo* manifests in interesting ways."

Part of the anger was down to the fact that fans expected to hear more about the next major *Diablo* game release at Blizzcon, and some were hopeful of a full *Diablo 4* reveal. "We knew our audience here desperately wants to see and hear about one thing in particular," Adham said.

Adham headed off accusations that *Diablo Immortal* was just a reskin of another game by NetEase, which Blizzard has partnered with for *Immortal*'s release. He said that the art and assets for new game were themselves completely new, and that *Immortal* was "purpose-built from the ground up". Undeniable similarities in UI between *Immortal* and *Crusaders of Light* were simply a result of the control scheme NetEase had adopted in previous games becoming "ubiquitous". Samuel Horti

"We knew our audience here desperately wants to see and hear about one thing in particular."



To the stars

Stellaris reveals 'economy-focused' MegaCorp expansion.

You've befriended the stratosphere's gentle giants, and have made peace with your space angry neighbours, so what's left to conquer on your *Stellaris* journey? The financial market, reckons Paradox.

Stellaris has unveiled its "economy-focused" MegaCorp expansion, a "revolutionary new way to conduct business on a galactic scale by seamlessly synergizing new markets and city planets with state-of-the-art citizen solutions and more marketable human capital." You'll erect trade buildings, head companies as CEO, secure trade agreements, and strive to build your planet and ever-growing financial network's value. Joe Donnelly



RTS classic born again

WARCRAFT 3 IS BEING REMASTERED, COMING NEXT YEAR.

Warcraft 3, the seminal RTS that really kickstarted *Warcraft* as a major franchise and launched a little mod called *DOTA*, is being remastered. Called *Warcraft 3: Reforged*, this remaster will be coming "next year" and will feature an all new coat of paint, updating the graphics and animations to look stunningly hi-res (4K is supported) while still retaining that goofy *Warcraft* charm. There's some cool new features too, though. Each playable hero will be available as either male or female, and there will be skins to customize their appearance in-game. Don't worry though, as *Reforgerd* will also have an editor so you can still make your own maps and gamemodes. This was a surprise announcement out of Blizzcon 2018, but we kind of had a hint that this might be coming due to the fact that the original *Warcraft 3* received some patches in the past year – a surprise, considering how old it is. *Warcraft 3: Reforged* will be out next year. Steven Messner

Destiny 2: Forsaken expansion hasn't satisfied Activision's money needs

ACTIVISION ISN'T HAPPY WITH THE SALES PERFORMANCE OF DESTINY 2'S RECENT FORSAKEN EXPANSION.

In a recent earnings call, Activision COO Coddie Johnson said the expansion's efforts to re-engage "core" players hasn't quite gotten there yet. "We have not yet seen the full core re-engage in *Destiny*, which has kind of led to the under-performance against our expectations to date," Johnson said. "Some players we think are still in wait-and-see mode. So when you're in, you're deeply engaged. If you're not, we're hoping now's the time to bring players back in and win them back." *Destiny 2* released to positive reviews but was widely considered to be under-supported by enthusiasts. *Forsaken* was widely believed by critics to remedy many of the vanilla game's problems, but perhaps Activision and Bungie left it too late. *Destiny 2* director Luke Smith later Tweeted that Bungie itself is not disappointed with *Forsaken*. "We set out to build a game that *Destiny* players would love, and at Bungie, we love it too," he said. SP

Hacker scores US\$20,000 for unearthing Steam flaw

Researcher and hacker Artem Moskowsky discovered a flaw in Steam's developer portal which allowed users to generate an infinite number of game codes. Moskowsky notified Valve of the issue and was awarded US\$20,000, which is a much easier way of making money than generating game codes and hocking them off on third-party key reseller sites. The flaw has now been fixed up. SP

Intel Extreme Masters will bring pro CS:GO back to Sydney in 2019

Intel Extreme Masters will return to Sydney in 2019 for the third year running, bringing world class *Counter-Strike: GO* play to the city's Qudos Bank Arena. Sixteen teams will compete for a US\$250,000 prize pool, with winners working towards attendance at the Intel Grand Slam. The proceedings take place May 3-5 2019, but you can get in early for tickets, which are onsale now. SP



Odyssey is a lot more than just another Assassin's Creed, it's an RPG of unparalleled scale.

FROM \$95 | PC, PS4, XO | ASSASSINSCREED.UBISOFT.COM

Assassin's Creed Odyssey

Another thoroughly engrossing winner.

Odyyssey sheds so much of what *Assassin's Creed* is known for to fully embrace the core concepts of a roleplaying game – and it's all the better for it. Even though the story doesn't live up to its initial premise, the additional layer of choice, breathtaking scenery, and colorful sidequests make *Odyssey* not only the best *Assassin's Creed* to date, but one of the best RPGs since *The Witcher 3*.

Unlike previous *Assassin's Creeds*, dialogue options now let me influence major and minor quests – sometimes with horrific consequences. I refused to intervene when a priest wanted to put a plagued family to death, incited more than one rebellion, and even spared a shamed general from what should have been a very satisfying dish of stone-cold revenge. And, yes, I've also bumped uglies with quite a

few willing characters.

These frequently wonderful side quests are spread out over a world that is almost incomprehensibly large for a single player RPG. Normally size doesn't matter, but the sheer scale of *Odyssey's* ancient Greece is to its benefit, especially because each area feels so distinct and detailed. It's a vast world that I want to explore, and each zone has a subtle aesthetic that makes it unique, from the arid badlands of Crete to the verdant plains of Arkadia. This isn't just Ubisoft's biggest game ever, it's also its most beautiful.

One thing worth mentioning is that *Odyssey's* story features some pretty stiff level gaps that have to be overcome by diverting time to complete side quests and other activities. I didn't mind it, since all of those experiences are fun, but it will be annoying to anyone who wants to just focus on

the main quest.

Odyssey retains the same MMO-style leveling system of *Origins*, meaning enemies who outrank me by even a few levels will be practically invincible no matter how well I fight. That's still annoying – especially when I want to take on a new story quest but discover its level is beyond mine – but in the case of mercenaries I like how it establishes a food chain. When I saw Exekias the Legend, a level 50 merc, roaming around Delphi with his pet bear, I felt like I bumped into a celebrity.

Fans of older *Assassin's Creed* games can rest easy knowing that stealth is still big part of *Odyssey*. Sneaking into heavily guarded forts and estates is how I've spent a good half of my time, but the system remains largely unchanged from previous games. I still use my eagle to mark enemies and various objectives, and there's still

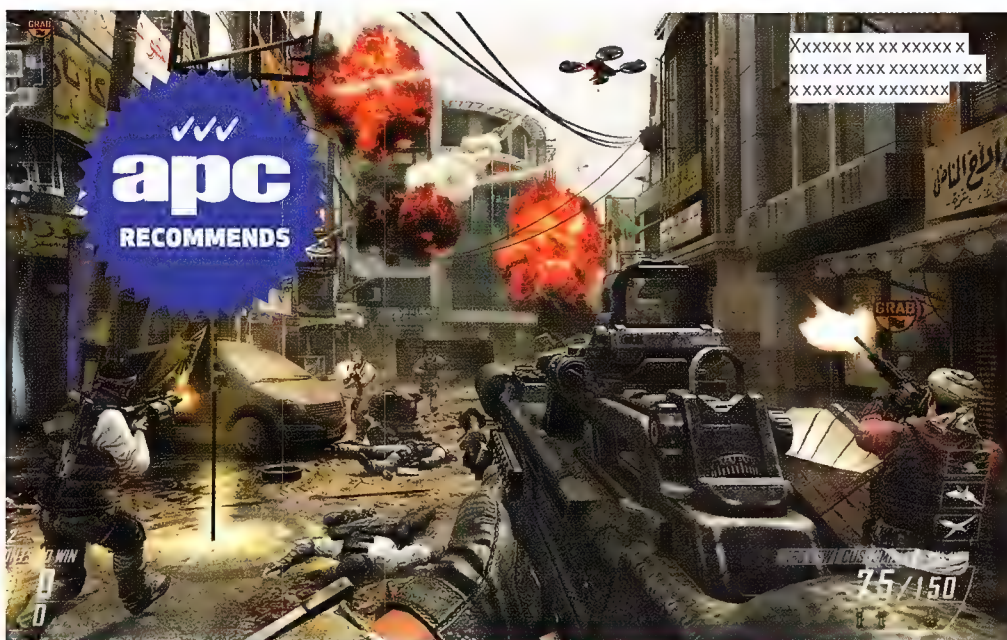
that familiar tension of trying to slink through an enemy camp unseen.

Assassin's Creed Odyssey is enormous and beautiful, and it effortlessly ties action, stealth, sailing, faction control systems, mercenaries, and cultist hunting together into one cohesive game that, even after 50 hours, I want to keep playing. *Odyssey* is a lot more than just another *Assassin's Creed*, it's an RPG of unparalleled scale supplemented by satisfyingly layered and deep progression systems that each play their part in bringing ancient Greece to life. ■

Verdict

Ubisoft's biggest and most beautiful game ever.





FROM \$69 | PC, PS4, XO | WWW.CALLOFDUTY.COM

Call of Duty: Black Ops 4

No more single player mode.

Call of Duty: Black Ops 4's take on battle royale, *Blackout*, feels like an unintentional commentary on the series as a whole. It's a nakedly sales-driven version of one of the most popular trends in gaming right now, expertly-tuned to the whims of a capricious gaming community.

Treyarch has jettisoned the usual glossy eight-hour corridor campaign from this year's game. Its absence leaves the singleplayer relatively meager this time around, limited to solo zombie-stomping with bots or lone missions that star the game's cast of multiplayer 'Specialists.' *Black Ops 4* is solely a game about shooting your friends or shooting with your friends, and if the battle royale mode weren't so fun, it'd feel a little thin.

Compared to its battle royale contemporaries, *Black Ops 4* might be a refinement rather than a revolution, but it's still the best version of a realistic battle royale (or at least, more realistic than *Fortnite*) that I've played—zombies aside—and I plan to go back to it for weeks to come. The



messy gunfights and clutch finishes make me want to jump back in repeatedly, and that's ultimately the metric that matters the most to me.

There's an absolute tonne of undead to slaughter in *Black Ops 4*, including two brand-new maps and a remake of *Black Ops 2*'s Mob of the Dead, along with a remake of the original *Black Ops*' Five that comes with the optional season pass. But after over fifteen hours of headshotting the undead, I felt a deep urge to play through *Left 4 Dead 2* again.

It can be hard to remember that this is the series that redefined the online shooter just a decade ago. *Black Ops 4* is what it says on the back of the box, and little more, but

the weapons are fun to use and its lighter, faster take on battle royale is best-in-class, at least at this early juncture for the genre. So even though nothing about it is surprising, this year's *CoD* still gives me what I want after 15 years of blasting through the series: all-adrenaline, with guns that are a joy to use. ■

Verdict

A STRIPPED DOWN TAKE ON THE FRANCHISE.



Rainforest

Warehouse adventures.

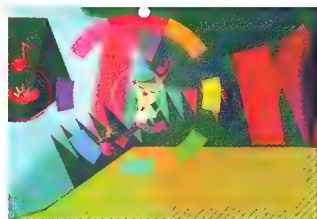
FROM FREE | PC
SIMOGECKO.ITCH.IO/

Rainforest is a small game that puts you in the role of a stressed-out employee in a warehouse owned by an Amazonesque online store. In this small arcade-style game, you have to run frantically between conveyor belts spitting out packages of various sizes, before stacking them onto your trolley and pushing them to the appropriate shelving units. If a package falls to the floor before you get to it, there's a good chance it'll be damaged. If three packages are ruined, you will lose your job and, well, the game.

It's not a complicated game, but to reach the peak of the high score table you'll need to collect packages in a tactical order, filling every crevice on your trolley, like Tetris, before delivering them to the correct shelves in an expedient manner.

With only a single stage on offer, there isn't much meat to *Rainforest*. Also, the tiny art assets can be difficult to read, making it tricky to differentiate the variously sized packages. It is at least an enjoyably barbed jab at a certain monopolistic online store. ■ Simone Guggiari





The Gardens Between

A matter of time.

\$19.99 | PC, MAC, PS4
WWW.THEVOXELAGENTS.COM

A beautiful but all-too-brief brain-teaser from an Australian studio, *The Gardens Between* features vivid visuals and a delicious ambient soundtrack, but it's easily finished inside three hours.

Playing *The Gardens Between* requires just three controls – a pleasantly low barrier for entry. You move time forwards and backwards within each meticulously detailed stage with the left stick, while the Switch's A button sees either of the game's protagonists, neighbouring kids Frenndt and Arina, interact with a small array of in-game elements in front of them.

These vary wildly, despite being in limited supply per level. Whatever the dreamlike stage, Arina must deliver an illuminated lantern to an exit point to complete it. It's never already shining, so a light source must be found somewhere between A and B. Excellent for its duration, *The Gardens Between* isn't one to rush back to once completed, revealing its entire hand at the first time of asking. But while it undoubtedly ends too quickly, as a calling card of terrific imagination, this game is quite the statement of intent from its makers. ■



FROM \$79 | PC, PS4, XO | WWW.EASPORTS.COM/AU/FIFA

FIFA 19

Kicking it a little further.

It's often said that football's a game of clichés. Commentators and pundits are only too happy to lean on a lexicon of well-worn expressions to describe the game, and after two decades of fierce rivalry between *FIFA* and its perpetual adversary *Pro Evolution Soccer*, there's a glossary of clichés just for their relationship. They all ring absolutely true of each series' latest installments, too: *PES* is once again superior on the pitch but remains twenty years behind in presentation, while *FIFA*'s wealth of official licenses and modes will make for a superior overall package.

Those high production values are especially apparent in *FIFA 19*'s story mode, *The Journey*. This is the concluding chapter of Alex Hunter's earnest and enjoyable rags-to-riches tale, told once again via a mixture of cutscenes and on-pitch action. This time Alex, his sister Kim, and childhood friend Danny Williams all have deep career paths that can be cycled at will, shedding the previous structure in which Kim's big



break for the US women's national team was an aside in Alex's story, for example. The new structure works well, depicting the sport in a broader focus than before, across domestic and international fixtures, and the mens' and womens' competitions.

The on-pitch improvements aren't always easy to spot, but they're there. Jostling for the ball now feels less like two players locked into a canned animation with a predetermined outcome, and more like a physical simulation of two solid bodies that's not to say it's easier to muscle past defenders en route to goal across the board, but it does

mean the strength and speed player stats carry much more meaning in *FIFA 19*.

Depending on your threshold for corniness, you could argue it's worth it for *The Journey Alone*, and although *PES* feels like the more organic, spontaneous and subtle game of football, EA Sports' latest effort isn't far behind it. ■

Verdict

Another set of incremental improvements.



apc
RECOMMENDS



USD\$29.99 | PC | WWW.FROZENSYNAPSE2.COM

Frozen Synapse 2

Superlative turn-based strategy that'll melt your brain.

Taking control of a security force tasked with eliminating a sentient AI, *Frozen Synapse 2* sees you battle your way through isometric maps, while planning, testing and routinely reworking your combat strategy. After deploying your troops, you issue a series of intricate commands to each individual soldier, giving them orders to move into position, shoot at or ignore enemies, or duck for cover. These delightfully tactical turn-based encounters take place in increments of five seconds, meaning that acute attention to detail and meticulous execution is the order of the day.

Fortunately, you're granted the gift of foresight for concocting your segmented plan of attack: you can issue endless orders to your units and watch the resulting scenarios without having to commit until you're satisfied with the outcome. When you're done daydreaming about how useful that function would be in real life, you can use it to save hapless soldiers who've unwittingly fallen foul to a hail of enemy gunfire, or get your soldiers into position to pull off the perfect shot. As long as you remain undetected, you can even see enemy movements; open fire or get spotted, however, and the opposition's manoeuvres are reduced to

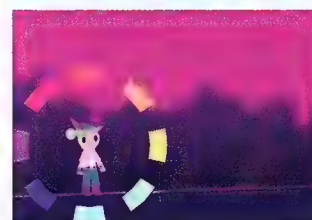
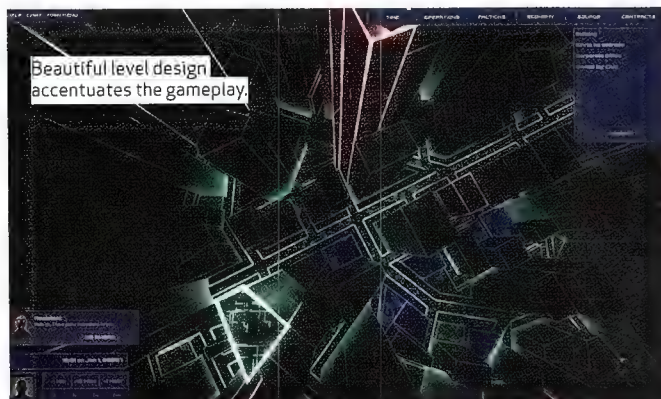
educated guesswork involving trial and error tactics.

When you tire of battling armies of AI opponents, there's also a robust multiplayer on offer to test your tactics against other payers. The unpredictability of human opponents makes for vastly more thrilling and memorable encounters compared to playing alone. A variety of different modes greatly extends the game's lifespan, including 'One Turn', a mode in which you must complete the objective in a single round to achieve victory.

More casual strategy enthusiasts may be put off by *Frozen Synapse 2*'s overwhelmingly considered approach to conflict, but the game's slow pace and second-by-second execution of the perfect strategy can make for a thrillingly tense experience. ■

Verdict

More than mindlessly mowing down waves of enemies.



Wandersong

Saving the world, one song at a time.

FROM US\$20 | PC, SWITCH
[HTTPS://WANDERSO.NG](https://wanderso.ng)

Wandersong is charming from the off. I was walking to-and-from the main village of the first act, and, without really needing to – without there being a puzzle to solve or character to impress – I started singing. *Wandersong* is a game about singing. Move the mouse (or the control pad's right analogue stick) in one of eight directions and you'll sing a different note. Throughout the game, you will use this central interaction in many enjoyable and surprising ways.

As you move through the story, *Wandersong* reveals its deeper layers. It starts to subvert your expectations of this non-heroic bard's heroic adventure. Your grand quest is filled in by the smaller, more personal stories that are the game's true heart. It becomes a game about loss, acceptance, regret, friendship, and the intimacy of colliding with another person's life. It's usually funny, but sometimes sad, and while the big story beats border on saccharine, it's the smaller character details – the people you meet along your journey – that ultimately resonate. ■





DEVELOPER: NEVERSOFT PUBLISHER: ACTIVISION RELEASED: 30 SEPTEMBER 1999 SYSTEM: PSONE, NINTENDO 64, DREAMCAST

GAME CHANGER

Tony Hawk's Pro Skater

Looking back at one of the most important licensed sports titles and the series it helped to spawn.

Just how much did Neversoft's take on the tricks and friendly competition of skateboarding go on to influence the concept of the wider sandbox playground experience in gaming? It's hard to quantify, but we're going to say quite a lot. It may have been driven by specific cultural and sporting traditions to create the game that it did with *Tony Hawk's Pro Skater*, but through it and the games that would follow, it helped to develop a benchmark for what it means to create a fun, anarchic and free-form space to just play in an open-world game.

And all of this because it decided to stick skate parks at the end of race courses in an early test of a skateboarding game, only to realise that – rather than just being a place to kill time until the other racers had finished – this was where most players wanted to spend their time. But we're getting ahead of ourselves. Neversoft's journey to making the most iconic and cherished of action sports

titles and series in gaming was an odd one, and it's interesting to retell it, if only for context.

Neversoft was a relative unknown before being signed up by Activision to work on a Bruce Willis-led shooter called *Apocalypse* and a skateboarding prototype. It had only released one game after a series of other projects were cancelled or fell away for various reasons, but in the race for teams who could adapt to the new 3D era in the late-nineties, Neversoft was clearly capable of handling itself.

Since *Apocalypse*'s 3D engine seemed to work pretty well, it was utilised for the production of this skateboarding project, still yet to have a name or any licensing attached to it. Early versions were heavily inspired by *Top Skater* from Sega and *Street Sk8er* from EA, with levels that were constructed as downhill races, but also encouraged tricks along the way. As we mentioned before, Neversoft smartly designed small skate parks at the bottom of the tracks with the intention

Key facts

■ The original build of *Pro Skater* that Tony Hawk played and that convinced him to sign onto the project actually had Bruce Willis (holding a gun) on the skateboard, since that was a character model from Neversoft's previous game, *Apocalypse*.

■ Motion capture of Tony Hawk was used to help make the animations as authentic as possible, but before he signed up, the capture was actually done with members of the development team themselves.

that players could kill time there while they waited for others to finish the course. In testing, however, this proved to be where the most time was spent by players, so the team pivoted towards making it the focus of the experience, embracing the feedback it was getting from its potential fans.

This was a massive breakthrough for a number of reasons, one of the more important being that skating around a park or in abandoned spaces much more closely replicated the way most people actually experienced skateboarding in the real world, whether on the boards themselves or watching their friends. They weren't taking part in races and competitions, they were out in the streets, creating their own fun, and Neversoft was embracing that aspect of the culture.

Embracing the culture is really the very core of what would ultimately make this game *Tony Hawk's Pro Skating* and turn it into a series to be reckoned with. Securing the name and branding of the sport's most prominent practitioner, of course, was also a major step in that journey – having Hawk himself regularly playtest new versions of the game through development helped maintain some authenticity.

The aspect of the culture that has probably been most heavily lauded over the years was the soundtrack. Its mix of punk, rock and hip-hop was not only a perfect reflection of the music that young skaters were blasting out of their boomboxes at parks and empty pools around North America, it was also one of the first great examples of a licensed soundtrack in the CD gaming era. It marked *Tony Hawk's Pro Skater* as not just a skateboarding simulation, but a fuller skateboarding experience that celebrated not just the skill and technique of the sport, but the fandom and lifestyle as well. And it's a soundtrack that, ahead of series such as *Guitar Hero* and *Rock Band*, was cited by the bands involved as a massive boost to their tour turnout and really helped album sales.

Ultimately, however, we have to come back to the pure construction of the game and its mini-sandbox feel. The campaign mode of *Pro Skater* had you working under a time limit to collect tapes through completing challenges before the clock runs down. It invited exploration, but more importantly forced replays as you learnt the layout and worked out a route that allowed you to hit all of the key points. Collecting everything and unlocking tapes was essential to unlocking the next stage, but it was also fun in and of itself, which is something we've seen repeated on a much wider scale in games like *Crackdown* or more recently *Spider-Man*, in which small collectibles

The rise and fall of the *Tony Hawk's* series

The games that marked the best and worst moments of the franchise.



Tony Hawk's Underground

In many ways, *Underground* represented the incredible crossover power of the *Tony Hawk's* series up to this point, tapping into the growing *Jackass*-style culture of extreme reality and pop-punk sensibility even more than its early releases had done. It was anarchic, ridiculous and still a lot of fun to play.



Tony Hawk: Ride

Activision's ill-fated attempts to break into the peripheral and motion-gaming booms of the age would ultimately send the *Tony Hawk's* gaming brand down a dark path as it seemingly surrendered the simulation market to EA's *Skate* and lost much of its core fanbase as a result. This skateboard peripheral-based game just wasn't much fun.

unlock upgrades and enhancements.

In the years that have since passed, the *Tony Hawk's* series has sadly declined, but it enjoyed fantastic success immediately following *Pro Skater* – it embraced its more extreme and bizarre side with *Underground*, and attempted to break into motion controls with *Ride*, which we would suggest lead to the series unfortunately losing its way. But *Pro Skater* set the bar for action sports experiences and limited open-world level design.

Following on from *Pro Skater*, we would see *Jet Set Radio* build up even bigger and crazier antics on roller-



Tony Hawk's Pro Skater 5

One last attempt to put the series back on its original path of fun, accessible sports action ultimately seems to have been the final nail in the coffin. *Pro Skater 5* was attempting to call back to the simple pleasures of the original games, but delivered it with such bland level design and poor graphical quality that it left us wondering why anyone bothered.

skates, while EA would eventually return to skateboarding with something closer to a sim experience with *Skate*.

Also, of course, 3D open-world design would embrace the timed challenge and collectibles model that Neversoft's game made clear was a wildly successful way to structure an experience, expanding the structure out over bigger worlds with more complex systems and traversal mechanics. And, critically, it helped get a lot of people into skateboarding, into the culture around skateboarding and into the music around the scene. ■



OFFICE OF
INSPECTOR GENERAL
U.S. DEPARTMENT OF THE INTERIOR

OCT 17 2018

Memorandum

To: William H. Werkheiser
Acting Director, U.S. Geological Survey

From: Matthew T. Elliott
Assistant Inspector General for Investigations

Subject: Management Advisory USGS IT Security Vulnerabilities

The Office of Inspector General (OIG) initiated an investigation into suspicious internet traffic discovered during an IT security audit of the computer network at the U.S. Geological Survey (USGS), Earth Resources Observation and Science (EROS) Center satellite imaging facility in Sioux Falls, SD. The audit found indications that USGS employee [REDACTED] compromise occurred.

We found that ██████ knowingly used U.S. Government computer systems to access unauthorized internet web pages. We also found that those unauthorized pages hosted malware. The malware was downloaded to ██████ Government laptop, which then exploited the USGS's network. Our digital forensic examination revealed that the 9,000 web pages ██████ visited routed through pornography websites. Many of the 9,000 web pages ██████ visited contained and displayed websites that originated in Russia and contained malware. Our analysis confirmed that many of the pornographic images were subsequently saved to an unauthorized USB device and ██████ personal cell phone connected to ██████ Government-issued computer. We found ██████ personal cell phone was also infected with malware.

During the investigation, we identified two vulnerabilities in the USGS' IT security posture: web-site access and open USB ports. Malware is rogue software that is intended to damage or disable computers and computer systems. In addition, a common goal of malware is to steal confidential information while spreading to other systems. Common methods to prevent malware incidents involve a combination of employee training (Rules of Behavior) and access controls (hardware and software technologies).

The U.S. Department of the Interior's (DOI's) IT Rules of Behavior prohibit employees from using DOI systems for illegal or inappropriate activities, explicitly including the viewing or distribution of pornography (Rule 6). The IT Rules of Behavior also direct employees to refrain from connecting personal devices, such as USB drives and cell phones, to Government-issued computers or networks (Rule 9). The USGS currently does not disallow USB connections on Government-issued computers.

Extensive NSFW browser history
responsible for secure network breach.

One US Government official's at-work porn habit is believed to be responsible for malware found on a secured government network. An audit of the US Geological Survey network at a South Dakota satellite imaging facility, found that somewhere amongst the thousands of porn pages visited by an unnamed employee, malware had managed to download itself onto a work laptop, before migrating to the network. A number of the images were downloaded to the government-issued computer before being saved on an unauthorised USB and a personal Android device – both of which are believed to also be infected with the malware.

GAG ORDERS CAN NOW BE SERVED BY CODE.

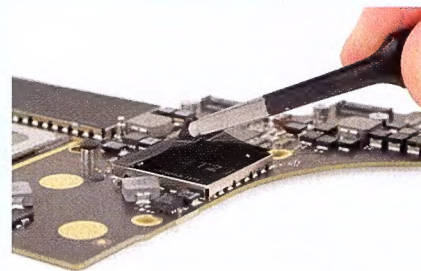
Xinhua News Agency, China's most influential state-run press core (and incidentally the biggest media outlet on the planet, by the number of international correspondents) introduced two AI anchors to its team at the World Internet Conference in November. The English speaking AI presenter has been built from the expressions and narration of human anchor Zhang Zhao and the Chinese language AI-anchor draws from fellow Xinhua presenter Qiu Hao. The press company remarked that its newest additions were capable of working "24 hours a day", something that is beyond us mere humans. This sentiment was reiterated by the AI's self-delivered introduction, which stated: "I'll work tirelessly to keep you informed".



Poop deemed to be the most distinguishing feature between mankind and AI

KEEPING IT CLASSY, HUMANS.

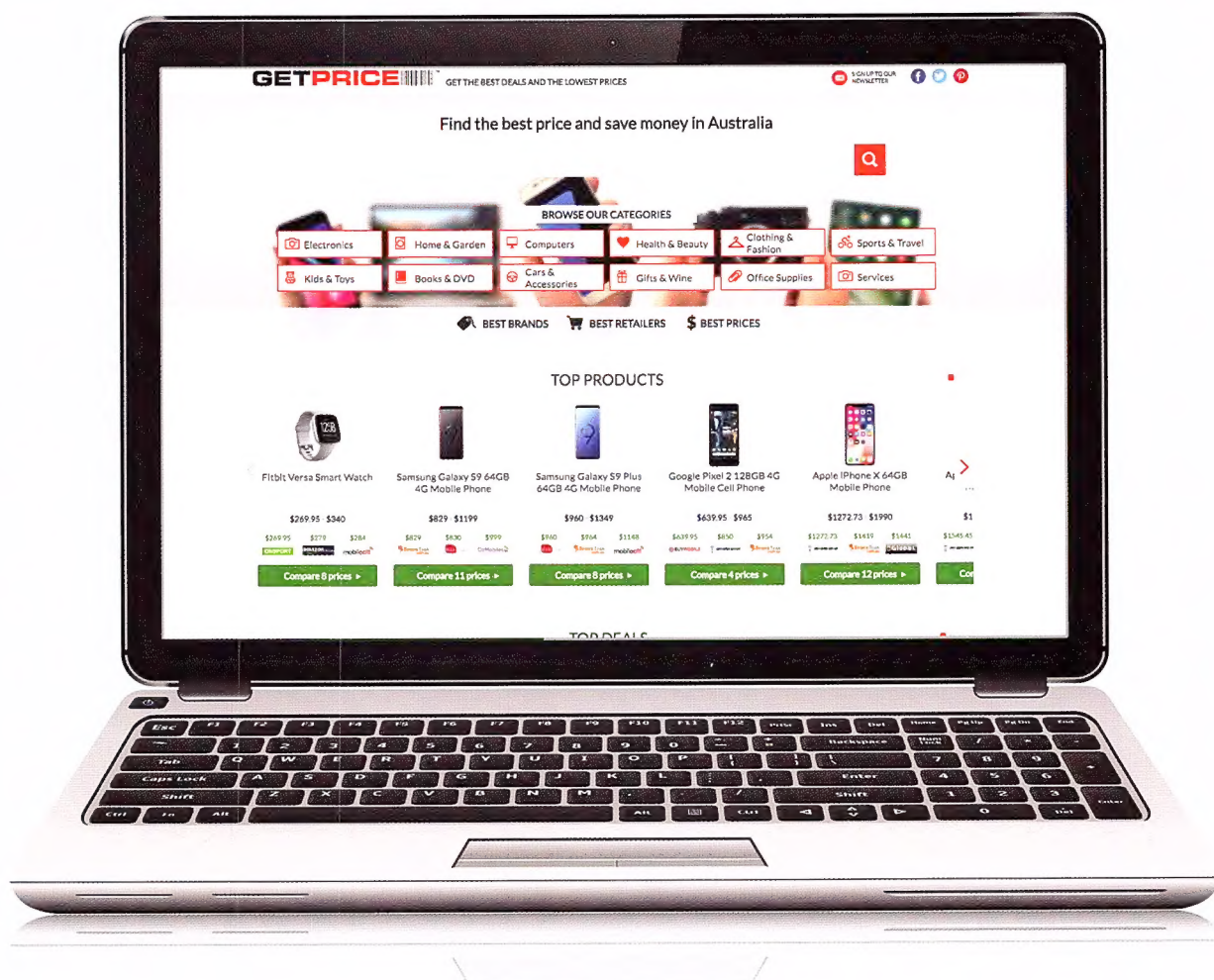
It's pretty clear that neural net chatbots can fool contemporary turing tests, but two researchers from MIT believe that rather than reflecting how 'intelligent' AI is, that this just shows how good AI is at exploiting human's prejudices. In an attempt to find the blind spots in our human radar, the researchers developed a 'Minimal Turing Test' which asks subjects to choose between two presented words for the one that most reflects their humanity. In this particular test, one word statistically stood out as something that humans believed was far more human than anything else: 'poop'. AI may one day take our jobs and and all our resources, but they'll never take our potty humor.



Apple confirms iMac chip blocks 3rd party repairs

PROPRIETARY T2-CHIP DIAGNOSTIC TOOL
TAMES ANY TINKERING.

It was first reported in October that Apple's latest T2 chips, found in its 2017 and 2018 iMac Pro and MacBook Pro units, included components that would lock down machines repaired by third parties using a proprietary diagnostic tool. The Cupertino company finally revealed to *The Verge* in November that its T2 chips did in fact include a proprietary diagnostic tool that would need to be run after particular types of repairs, for the machine to work again. While details on exactly which Apple devices these restrictions apply or what kind of procedures it limits are currently unknown, locking out third party repairs is a big change in Apple's repair policy and the concept of tech ownership of affected Apple products. ■



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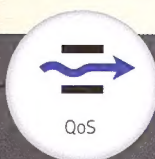
VDSL2/ADSL2+



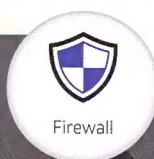
2.4Gz&5Gz
dual-band



Auto
Failover /Fallback



QoS



Firewall

- ✦ Compliant with VDSL2/ADSL2+ Standard
- ✦ Triple WAN for 3G/4GLTE, VDSL2/ADSL2+, and EWAN for broadband connectivity
- ✦ Auto Failover and Fallback
- ✦ Simultaneous dual-band wireless 802.11ac 1300Mbps (5GHz) and 802.11n 300Mbps (2.4GHz) support

- ✦ 5 Giga Ethernet ports included, port #5 can be configured as Ethernet WAN
- ✦ QoS and firewall supported
- ✦ 2 FXS ports for SIP VoIP call (option)
- ✦ VPN tunnels for IPSec, OpenVPN, GRE, L2TP, and PPTP connections (option)